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SEED TREATMENT OF VEGETABLES FOR CONTROL OF DAMPING-OFF [1]

B. P. TAMAYO and F. T. ORILLO [2]

In a test of five fungicides for pre-emergence damping-off control, significant differences between the treatment and the control were obtained in three of the six vegetables used. At dosages of 0.5 per cent by weight of the seeds, Granosan and Semesan increased emergence of pe-tsai seedlings very significantly. Similarly, a very significant increase in emergence of cabbage seedlings was derived from the Spergon treatment. Spergon also increased the emergence of eggplant better than the other treatments. Granosan, Semesan, and Arasan SF-X injured lettuce seeds.

Crag 5400 and Granosan proved to be high in protective value especially on cucumber seedlings. No sufficient protection against post-emergence damping-off was effected by the fungicides although better stands could be found on the treated rows than on the untreated ones, 14 days after emergence.

Damping-off of seedlings in the seedbed is one of the chief problems in vegetable growing. It is largely caused by fungi that usually live in the soil although some of them may be carried in or on the seeds. Recently developed chemical seed treatments have been found to be effective against certain diseases caused by seed- or soil-borne pathogens. Leukel (1936) [3] reported that benefits derived from seed treatment can be traced to the control of organisms found either on or in the seed or seedbed.

Walker (1948) [4] reported that seed treatment for the control of diseases began as early as the seventeenth century, although little attention was given to vegetable seed treatment before 1900. From 1900 to 1925, major attention was directed toward vegetable seed treatment to disinfest or disinfect them; seed protection received only minor attention, the notable example being the formaldehyde-drip control of onion smut. From 1925 to 1932, however, vegetable seed protectants came into use.

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[1] Central Experiment Station Contribution No. 1934.

[2] The authors thank Dr. A. G. Newhall, former Cornell visiting professor, for help in planning the experiment and for reading the manuscript.

[3] R. W. Leukel, *Botanical Review*, 2, 498-527 (1936).

[4] J. C. Walker, *Botanical Review*, 14, 588-601 (1948).

In the Philippines chemical treatment of vegetable seeds to protect them against the ravages of damping-off has not been thoroughly investigated.

To test the effectiveness of five fungicides used as seed protectants and to find out the value of seed treatment for controlling seedling diseases of some important vegetable crops, this work was performed from December, 1953, to March, 1955, in the laboratory and greenhouse of the Department of Plant Pathology, College of Agriculture and Central Experiment Station.

MATERIALS AND METHODS

The following vegetable varieties were used in the experiment: Chinese cabbage, No. 212; cucumber, Straight 8; lettuce, Great Lakes; tomato, Pearl Harbor; cabbage, Copenhagen Market; and eggplant, Native Long Purple.

At the start of the experiment seed samples of each vegetable were planted in sterile potato-dextrose agar to determine what fungi were associated with the seeds. The organisms were grown in pure culture and later compared with those isolated from the damped-off seedlings.

Seed viability was determined in every trial by sowing 100 seeds of each kind in autoclaved soil.

Garden soil previously planted to vegetables from the Department of Agronomy was used. To insure uniformity the soil was screened and mixed thoroughly by repeated shovelling before starting each test.

The fungicides tested were Spergon (98 per cent tetrachloro parabenzo quinone), Arasan SF-X (75 per cent tetramethyl thiuram disulfide), Semesan (30 per cent hydroxy-mercurichloro phenol), Granosan (5 per cent ethyl mercury phosphate), and an experimental fungicide, Crag 5400 (75 per cent alpha, alpha trithiobis *n*-dimethyl-thioformanide).

Weighed samples of the seeds together with the fungicides were placed in 125 ml. rubber-stoppered Erlenmeyer flasks and shaken vigorously for five minutes until the seeds were dust-coated. The control seeds were shaken in the same manner for the same length of time.

The fungicides were applied to the seeds in dry form at the rate of 0.5 per cent of the weight of seeds.

After treatment the seeds were placed in paper envelopes and kept in a desiccator for two days prior to sowing.

Seeds were sown in six flats 14 x 20 x 4 inches each. One hundred seeds were planted to a row, each row representing a different treatment. A control and two border rows made a total of 8 rows which were randomized in each flat. The flats were sprinkled with tap water once a day. The trials were repeated six times on different dates, each date corresponding to one replication.

When an appreciable emergence of the plants had occurred, daily counts were made of all the plants for a period of 14 days. Those that had damped-off were recorded and removed each time a count was made.

Isolations were made from the damped-off seedlings in the treated and untreated rows by cutting a portion of the water-soaked stems just above the ground and planting it in oat meal agar.

Percentages of emergence and final stands of seedlings, based on the number of seeds sown, were transformed into their corresponding angles (Snedecor, 1946)[5] and statistically analyzed.

RESULTS AND DISCUSSION

Effect on emergence of vegetables. Analysis of emergence data for each vegetable showed that seed treatment was effective for the five vegetables used. Percentage of emergence of treated and untreated seeds are given in the summary table at the end of this article.

On pe-tsai alone all treatments except Semesan gave highly significant differences over the control. Granosan gave the best result followed by Crag 5400 and Spergon. There were no significant differences between the five treatments.

Similarly, all treated cabbage seeds gave significantly better emergence than the untreated seeds. Differences indicated that Spergon and Arasan SF-X were the most effective materials for cabbage, but treatment with Semesan and Crag 5400 were almost as good.

In general, all treatments increased emergence of tomato, cucumber, and eggplant, but these increases did not differ significantly.

[5] G. W. Snedecor, "Statistical Methods Applied to Experiments in Agriculture and Biology," The Iowa State College Press, Ames, Iowa, 1946, pp. 446-450.

Treatment with Crag 5400 appeared to be the most effective on cucumber.

Seed treatment in lettuce proved injurious. Except for Spergon, all treatments gave poorer results than the control. Granosan and Semesan were the poorest. This result which indicates that mercurials are injurious to lettuce seeds is similar to the findings of the Seed Treatment Committee of the American Phytopathological Society (1946)[6] which reported that in 1944, Semesan gave the poorest result on lettuce among five fungicides compared. Spergon (2%)-treated seeds showed the most consistent benefits over untreated seeds.

Effect on final stand of seedlings. Fourteen days after all the seedlings had emerged, a final count was made in all the plants. On cucumber, Crag 5400 and Granosan differed significantly over the control. On pe-tsai, cabbage, eggplant and tomato, all the treatments gave the same stands as the control. On these vegetables no significant difference was obtained between the treatments and the control. Only Spergon gave better stands of lettuce seedlings over the control.

Occurrence of post-emergence damping-off. Immediately after the seedlings had emerged, post-emergence damping-off was observed in both the treated and untreated rows. This indicates that the fungicides did not give sufficient protection to the seedlings. The affected seedlings exhibited watersoaked lesions just above the ground surface and later damped-off. The trouble, however, was not serious on tomato and lettuce. The vegetables mostly affected were cabbage, pe-tsai, eggplant and cucumber. On these vegetables the disease continued as long as the seedlings were kept watered. Eventually all the seedlings were wiped out probably because the water used contained organisms which caused damping-off.[7]

Seed fungi and those which caused post-emergence damping-off. Morphological studies of the organisms associated with the seeds revealed no relation to those isolated from the damped-off seedlings. The fungi isolated from the seeds were *Aspergillus niger* Van Tiegh. and *Aspergillus oryzae* Alhburg.

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[6] American Phytopathological Society, *Plant Disease Reporter Supplement* 161, 1-66 (1946).

[7] Unpublished observation by Dr. A. G. Newhall.

Two fungi, *Pythium debaryanum* Hesse and *Rhizoctonia solani* Kühn, were isolated from the damped-off seedlings. Of these two, the more consistently isolated was *Rhizoctonia solani*. It appears that this fungus was largely responsible for the post-emergence damping-off observed in this study. No attempt was made to study the degree of infection of the two species on the seedlings.

SUMMARY

All the five fungicides tested on pe-tsai for pre-emergence damping-off were better than the control. Crag 5400 was effective on cucumber (suggestive F).

Spergon was best for cabbage, lettuce and eggplant while Arasan gave better emergence of tomato seedlings.

Arasan SF-X and mercurials like Granosan and Semesan were found injurious to lettuce. These fungicides did not only retard the germination but also reduced emergence of lettuce seedlings.

Cucumber seedlings derived most benefit from the seed treatment. Crag 5400 and Granosan were equally good in protective value as compared with the control.

No sufficient control of post-emergence damping-off was given by the fungicides tested at dosages of 0.5% of the weight of seeds in which *Pythium debaryanum* and *Rhizoctonia solani* were the chief soil infestants. In general, more seedlings of all the vegetables, did not damp-off in the treated rows than in the untreated rows.

The commercial value of other dosage rates of these treatments can be determined by further study.

* * *

The scientist should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favorite hypothesis; be of no school; no doctrine; have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature.

—*Michael Faraday*

SUMMARY TABLE

A. *Percentage of emergence of treated and untreated seeds*

TREATMENTS	PET-TSAI	CABBAGE	EGGPLANT	TOMATO	CUCUMBER	LETTUCE
			I. *Means of percentage emergence*			
Check	77.5	26.5	61.5	80.7	80.7	56.2
Granosan	91.3	34.2	62.7	83.5	88.3	8.2
Semesan	88.2	40.7	66.2	86.0	88.0	25.5
Arasan SF-X	88.8	42.5	66.7	87.0	82.7	31.5
Crag 5400	92.0	39.8	67.2	86.0	90.3	38.3
Spergon	90.1	44.7	72.3	85.8	87.0	57.2
			II. *Transformed angles of mean percentages*			
Check	61.81	30.51	52.57	64.22	64.48	49.26
Granosan	74.36	35.63	52.69	66.15	70.40	14.77
Semesan	70.32	39.59	54.98	68.42	70.06	28.53
Arasan SF-X	71.08	40.54	56.13	69.38	66.89	33.98
Crag 5400	73.71	38.84	56.31	68.42	74.14	37.63
Spergon	72.28	41.86	59.30	68.15	69.64	49.27
SMD (5%)	= 7.57	= 7.23	Insig.	Insig.	Insig.	= 17.24
SMD (1%)	= 11.23	= 10.71				= 25.59

B. *Percentage of healthy seedlings, 14 days after emergence*

TREATMENTS	PET-TSAI	CABBAGE	EGGPLANT	TOMATO	CUCUMBER	LETTUCE
			I. *Means of healthy seedlings*			
Check	37.8	14.5	22.7	69.7	32.0	48.0
Granosan	55.0	18.7	34.3	72.8	64.0	8.2
Semesan	49.5	31.0	36.3	77.7	45.0	25.0
Arasan SF-X	58.7	27.0	33.5	76.5	52.3	29.8
Crag 5400	38.8	24.0	27.5	78.5	64.7	36.3
Spergon	52.0	26.3	35.7	80.0	51.7	48.0
			II. *Transformed angles of mean percentages*			
Check	37.66	21.34	27.62	56.94	33.28	43.95
Granosan	48.46	24.93	35.81	69.36	52.89	14.77
Semesan	45.08	32.65	36.87	62.99	41.70	28.16
Arasan SF-X	50.50	31.09	34.51	62.82	46.67	32.66
Crag 5400	37.66	28.47	31.12	63.15	53.72	39.66
Spergon	46.51	30.33	36.27	64.15	45.45	43.95
SMD (5%)	Insig.	Insig.	Insig.	Insig.	= 15.42	= 18.38
SMD (1%)						= 27.31

CONTROL OF SPROUTING IN ONION BULBS WITH MALEIC HYDRAZIDE [1]

JUAN C. ACOSTA and THOMAS L. YORK [2]

WITH THREE TEXT FIGURES

MH treatments applied two weeks before harvest had no effect on rotting at harvest time and on yield.

Regardless of concentration and method of application, MH reduced the percentage of sprouting significantly. Sprouting in control plots at the end of the fourth month was 44.8%, and in treated plots, 12.5%. Differences in percentage of sprouting in all fields and storages were highly significant.

Rotting was significantly greater in the dipped MH treatments than in the control. The MH spray treatments had less rotting than the dip treatments. Rotting was significantly greater in "common storage" than in cold storage.

Combined losses due to sprouting and rotting were significantly greater in common storage than in cold storage.

The production of bulb onions in this country is highly seasonal, most of the harvesting being done in March and April. Much of the crop is stored in "common storages" where the humidities and temperatures result in either bulb rot or sprout. Hence, prices of onions in the local market remain high throughout the year.

Researchers have found that maleic hydrazide (MH) sprayed on the green leaves of nearly mature onion plants inhibited sprouting when placed in storage. Johannessen and Oebker (1951) reported that pre-harvest foliar sprays of 0.25% MH applied to Early Yellow Globe and Brigham Yellow Globe onions reduced sprouting in a 16-week storage test at 32 to 40 degrees F and under simulated retail-store conditions five weeks after this storage period.

According to Wittwer and Sharma (1951) 0.25% of MH plus 1% Triton B 1956 wetting agent, at 75 gallons of water applied 2 weeks before harvest prevented sprouting of Yellow Sweet Spanish onion bulbs in storage. There was significant reduction at 0.05%

[1] Central Experiment Station Contribution No. 1935. This study was made possible by a grant from the Central Cooperative Exchange.

[2] The authors thank Dr. L. G. Gonzales and Mr. A. F. Celestino for their advice and assistance in the field experiments and Messrs. F. Dumpit and E. Reyes, Jr. of NOGROCOMA storage, Malabon, Rizal, for their help in taking care of the experimental materials placed in cold storage.

with some decrease in loss from storage breakdown, but no apparent effect on flavor, color or internal structure after five months in storage.

Wittwer *et al.* (1950) reported that MH applications of 2500 ppm completely inhibited sprouting even after four months. There was no significant reduction in root growth. With 500 ppm, sprouting was reduced significantly. Internal structure of the treated bulbs was normal and color, flavor, and odor were not affected.

Wittwer and Paterson (1951) stated that regardless of storage temperatures, sprays of 0.1% and 0.25% MH applied when leaves were green and bulbs were approaching maturity completely inhibited sprouting. Onions treated too early produced spongy, hollow-neck or puffy bulbs. MH pre-harvest foliar sprays completely prevented sprouting and bulbs remained dormant at relatively high temperatures when planted.

Paterson and Wittwer (1953) confirmed that there was no reduction in yield resulting from the spray treatment of 2500 ppm MH applied 29 or 11 days before harvest; there was a significant reduction in sprout and root growth, but the percentage of breakdown increased compared to the control. In the case of Y-40 hybrid onion bulbs following 18 weeks of common storage in bins of 200-bushels capacity, only 38% of the non-treated bulbs were marketable compared to 51% of those treated with MH.

Choudri and Bhatnagar (1953) reported that Patna variety of onion sprayed one month before harvest at 0.025%, 0.1% and 0.25% of MH reduced bolting. Suppression of bolting was associated with increase in bulb size. MH applied directly to the soil prevented bolting at all concentrations and effected better development of short roots. High concentrations hastened, whereas, low concentrations delayed maturing of flowers.

Paterson (1952) observed that low concentrations (500 and 1000 ppm) of MH applied shortly before harvesting stimulated sprouting.

Gonzalez and Tabing (1956) working on Red Globes grown in Nueva Ecija, found that all the concentrations of MH (2,000, 2,500, and 3,000 ppm) applied two weeks before harvest completely inhibited sprouting up to the end of the four-month period in common storage.

F. M. Isenberg [3] obtained from excellent to no control of sprouting of onion bulbs dipped for 1 minute in 4000 ppm and 6000 ppm MH solutions.

This experiment was conducted in Nueva Ecija and Los Baños farms from April, 1956 to October, 1956 to find out the best concentration, the best time and the best method of MH application on onions.

MATERIALS AND METHODS

Nueva Ecija Experiment

Onion fields in Bongabon, Abar, and Cabiao, Nueva Ecija[4] were each sprayed on April 5, 12, and 17, 1956, approximately two weeks before harvest. In each of the 200-square meter fields no spaces between plots were provided and thread tied to pegs was used to outline each plot from the time of spraying through harvest. During spraying, an improvised cardboard shield was used to prevent the spray applied to a given plot from drifting to adjoining plots.

Four different MH treatments were applied, two as foliar sprays (2500 and 3500 ppm) two weeks before harvest and two as bulb dips (4000 and 6000 ppm) at harvest. In the dip method, the newly-harvested bulbs were allowed to soak for one hour in a basin containing the desired concentration. The bulbs at Bongabon were rinsed in plain water before soaking in the appropriate solution. Root plates of the bulbs in two of the four replications of the dip treatments were smoothly trimmed before dipping while in the other two replications root plates were not trimmed. In all experiments, the dipped bulbs were packaged and moved to College, Los Baños, Laguna before they had dried thoroughly.

The number of good bulbs, rotting bulbs, and total weight of bulbs from each plot were weighed and subsamples were taken to College for curing. In Bongabon, 4 subsamples (maximum of each subsample of 50 bulbs) were obtained from each plot, but only two subsamples were taken from each plot in the other two experiments.

After a 2-week curing in College some were placed in common storage there and others in cold storage in Malabon, Rizal.

The bulbs stored in Malabon were in perforated paper bags which were placed in crates before storing, whereas, the bulbs stored in College were placed in specially made bamboo racks provided with divisions.

[3] Personal communication, September, 1955.
[4] Through the cooperation of FACOMA officials.

Monthly observations on sprouting and rotting were made and computed as the percentage of bulbs in the lot at the beginning of the experiment. Rooting was negligible and so no data were taken.

Los Baños Experiment

About 25 bulbs of the Exel variety harvested from the College experimental farm were classified into each of the following categories:

1. Large mature—Necks thin and dry
2. Medium mature—Necks thin and dry
3. Large green—Necks thick and hard to bend
4. Medium green—Necks thick and hard to bend
5. Small mature—Necks thin and dry

Three different concentrations of maleic hydrazide (MH 40) were prepared and applied by the *paint* and *toothpick* method. In all the samples, the root plate of the bulbs was cut off. Bulbs showing defect at the rootplate were discarded. Methyl cellulose (methocel) was added as an adhesive to MH, except in the solution where toothpicks were soaked. About 2.5 grams Methocel was mixed in 250 ml. of MH solution. The toothpicks were soaked in a 10,000 ppm solution for 40 minutes. Maleic hydrazide solution was painted on the rootplate wound and the toothpick was inserted at the middle of the plate to a depth of approximately one inch. The 3 MH treatments x 5 "grades" of bulbs x 3 monthly readings procedure was followed.

The bulbs were stored under the same common storage conditions already described.

EXPERIMENTAL RESULTS

Nueva Ecija Experiment

Observations at harvest. In the various fields there was considerable variability in maturity of bulbs. At Bongabon, for example, approximately 20% of the bulbs had dry tops, 20% were green and upright, and 60% had tops down which were still wet. Similarly, the bulbs showed much variability in root conditions; some were brown and withered while others were succulent and healthy.

The number of double bulbs was low in all fields. At Bongabon, harvesting was facilitated because the MH-sprayed plots had less weed. There was considerable purple blotch and bulb rot at Bongabon and considerable thrip damage at Abar.

Observations in storage. The temperature in the storage room in Los Baños ranged from 83.4° to 97.3°F with a humidity of 77%, whereas, in Malabon, the temperature varied from 32° to 36°F with an average humidity of about 70%.

Larvae of insects of the Family Tineidae [5] (Order Lepidoptera), were found attacking the bulbs of the Red Globe variety in common storage. Fungus diseases, *Penicillium sp.* (Blue mold), *Aspergillus niger* van Tieghem (Black mold) and *Fusarium zonatum* Wr. forma (Bulb rot) [6] attacked the bulbs. The damage caused by these diseases in cold storage was only slight compared to the damage of those in common storage.

After four months' storage, ten bulbs from each treatment of each variety were cut open. The treated bulbs did not appear distinctly different in appearance from the control bulbs. However, a small number of bulbs exhibiting negligible pithiness was found among the treated bulbs with thick necks.

In Bongabon (Red Globe) and Abar (Excel) MH treatment had no effect on newly-harvested yield and on rotting. The yields averaged 13,045 kg./ha. at Bongabon and 5,454 kg./ha. at Abar (average of all plots in each location). Harvested bulbs discarded because of rotting was 6% at Bongabon and 21.1% at Abar.

Effect on sprouting. The various MH treatments seemed to be similarly effective in reducing sprouting. Considering yields of all fields at the end of the fourth month in storage, 44.8% of bulbs in the control had sprouted whereas in the MH treatments only 10.4 to 14.5% sprouted. Rotting in common storage was significantly higher than in cold storage. At the end of the fourth month percentage of rotted bulbs in common storage was 79.2; in cold storage, 10.9 (fig. 1).

Varietal effect on sprouting and rotting. In the three fields, there were highly significant differences noted in sprouting and rotting (tables 1 & 2). These may have been largely due to the different varieties used in the experiments. Excel, the variety grown at Abar, had more rotting than the Red Globe grown in other fields.

Effects of time in storage on sprouting and rotting. For all treatments sprouting averaged 1.9% at the end of the second month, and 19% at the end of the fourth month.

[5] Identified by Dr. Silverio Cendaña of the Department of Entomology.
[6] All these diseases were identified by Prof. V. M. Ela of the Department of Plant Pathology.

TABLE 1.—*Monthly average percentage of sprouting in cold and common storages*

TREATMENT	FIELD	COMMON STORAGE					COLD STORAGE					MEAN
		M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	
Check	Bong.	2	4	20	48	18.5	0	0	0	34	8.5	13.5
	Abar	2	8	21	26	14.2	0	4	22	49	18.7	16.5
	Cab.	2	9	26	36	18.2	1	3	36	76	29.2	23.7
	Mean	2.0	7.0	22.3	36.6		0.7	2.3	19.3	53.0		
2500 (spray)	Bong.	0	0	2	12	3.5	0	0	0	4	1.0	2.2
	Abar	1	1	4	6	3.0	0	1	5	22	7.0	5.0
	Cab.	0	2	5	8	3.7	0	0	1	35	9.0	6.4
	Mean	0.3	1	3.6	8.6		0	0.3	2.0	20.3		
3500 (spray)	Bong.	0	0	3	8	2.7	0	0	0	11	2.7	2.8
	Abar	0	0	4	7	2.7	1	1	6	16	6.0	4.4
	Cab.	0	1	2	2	1.2	0	1	7	30	9.5	5.4
	Mean	0	0.3	3.0	5.6		0.3	0.7	4.3	19.0		
4000 (Dip)	Bong.	2	2	3	11	4.5	0	0	0	7	1.7	3.1
	Abar	1	1	2	3	1.7	1	2	6	11	5.0	3.4
	Cab.	1	1	4	5	2.7	0	3	12	40	14.0	8.3
	Mean	1.3	1.3	3.0	6.3		0.3	1.0	6.0	19.3		
6000 (Dip)	Bong.	0	0	2	4	1.5	0	0	0	8	2.0	1.8
	Abar	0	1	3	4	2.0	2	3	6	12	15.1	3.9
	Cab.	4	4	6	7	5.2	3	4	10	28	11.2	8.3
	Mean	1.3	1.7	3.7	5		1.7	2.3	5.3	16.0		
Mean		1.0	2.3	7.1	12.5		0.6	1.5	7.4	25.5		

Analysis of variance

SOURCE OF VARIANCE	DF	SS	MS	C-F-V	.05	.01
Treatments	4	3,430.9	857.7	44.44 [a]	2.77	4.03
Fields	2	677.7	388.8	17.55 [a]	2.66	3.29
T × F	8	154.4	19.3	—		
Months	3	6,259.3	2,086.4	186.30 [a]	1.78	2.41
T × M	12	3,092.3	257.7	23.00 [a]		
F × M	6	562.9	93.8	8.38 [a]		
Error	24	270.0	11.2	—		
Storages	1	276.1	276.1	8.79 [a]	2.06	2.76
T × S	4	20.8	5.2	0.17		
F × S	2	640.5	320.2	10.20 [a]		
M × S	3	1,011.1	337.0	10.73 [a]		
T × F × S	8	160.1	20.0	0.64		
Pooled error	42	1,319.4	31.4			
Total	119	17,875.5				

[a] Highly significant.
[b] Significant.

TABLE 2.—*Monthly average percentage of rotting in cold and common storages*

MENT TREAT-	FIELD	COMMON STORAGE					COLD STORAGE					MEAN
		M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	
	Bong.	8	22	43	48	30.2	2	3	3	3	2.7	16.5
Check	Abar	29	51	67	73	55.0	2	4	8	12	6.5	30.8
	Cab.	16	34	44	49	45.7	5	5	5	7	5.5	20.6
	Mean	17.7	36.0	51.3	57		3	4	5.3	7.3		
	Bong.	15	21	45	73	38.5	1	1	3	3	2.0	20.3
2500	Abar	31	64	84	93	68.0	3	5	9	12	7.2	37.6
	Cab.	16	35	57	74	45.5	0	0	0	5	1.2	23.4
	Mean	20.7	40	62	80		1.3	2.0	4.0	6.6		
	Bong.	4	19	46	77	36.5	2	6	6	6	5.0	20.8
3500	Abar	38	62	78	90	67.0	3	7	13	15	9.5	38.3
	Cab.	14	37	64	73	47.0	6	6	6	8	6.5	26.8
	Mean	18.7	39.3	62.7	80		3.7	6.3	8.7	9.6		
	Bong.	9	28	54	75	41.5	2	7	9	11	7.2	24.4
4000	Abar	61	82	93	97	83.2	2	7	15	22	11.5	47.4
	Cab.	27	39	68	88	55.5	5	5	5	7	5.5	30.5
	Mean	32.3	49.7	72.0	87		3	6.3	4.7	13.7		
	Bong.	14	26	63	93	49.0	1	5	5	5	4.0	26.5
6000	Abar	60	85	92	96	83.2	8	11	19	33	17.7	50.5
	Cab.	18	47	74	89	57.0	10	15	15	15	13.7	35.4
	Mean	23.3	43.5	64.8	79.2		3.5	5.8	8.1	10.9		

Analysis of variance

SOURCE OF VARIANCE	DF	SS	MS	C-F-V	.05	.01
Treatments	4	3,292.79	823.20	21.00 [a]	4.15	6.04
Fields	2	7,810.72	3,905.36	99.63 [a]	3.20	4.66
T × F	8	313.61	39.20	—		
Months	3	16,853.80	5,617.93	372.05 [a]	2.06	2.80
T × M	12	462.61	38.55	2.55 [b]	4.62	—
F × M	6	239.95	39.99	2.65 [b]	2.54	—
Error	24	362.39	15.10	0.30		
Storages	1	62,929.20	62,929.20	1,245.88 [a]	2.61	3.49
T × S	4	1,108.55	277.14	5.49 [a]	5.96	7.98
F × S	2	3,599.45	1,799.72	35.63 [a]	4.53	6.06
M × S	3	9,966.34	3,322.11	65.77 [a]	3.70	4.95
T × F × S	8	263.05	32.88	0.65		
Pooled error	42	2,121.41	50.51			
Total		109,323.87				

[a] Highly significant.
[b] Significant.

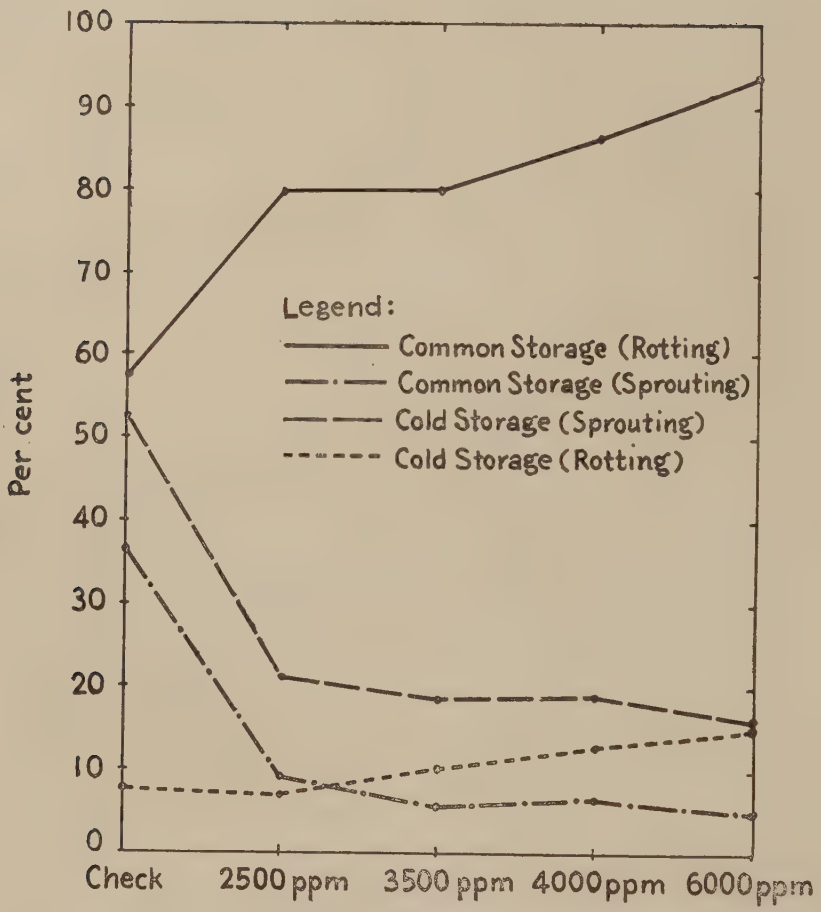

Fig. 1.—Mean percentage of sprouting and rotting from 3 fields after 4 months of storage in common and cold storages.

There was about the same percentage of bulbs discarded each month because of rotting. Much of the rotting of Excel bulbs occurred during the first month. The condition of the various treatments at the end of the fourth month in storage is shown in figures 2 & 3.

Four first-order interactions proved highly significant in the analysis of the Nueva Ecija experiments. The interaction between MH treatments and months in storage was due to the earlier onset of considerable sprouting in the control. The fields x months interaction was largely due to a marked increase in sprouting of bulbs from Cabiao during the fourth month.

Fig. 2.—Representative bulbs from each treatment after four months in cold storage, upper panel. Lower panel, bulbs stored in common storage. (*Photograph taken by the Photographic Division.*)

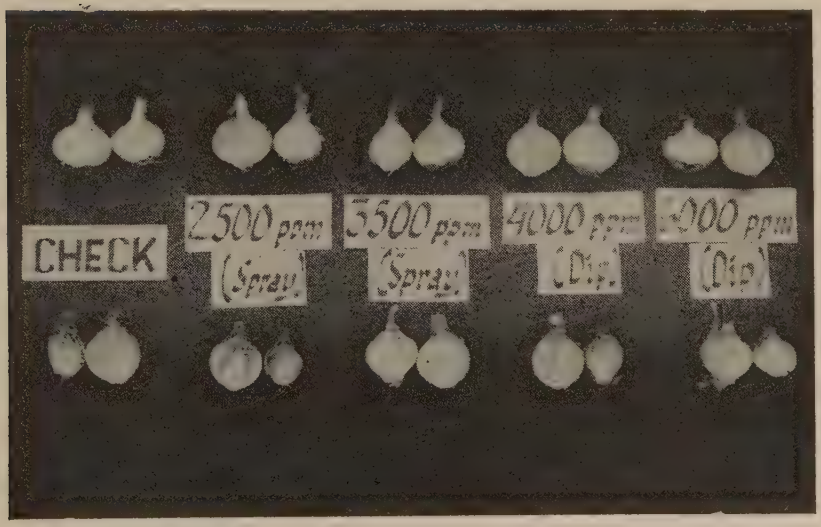

Fig. 3.—Longitudinal section of two bulbs from each treatment. (Some order as in Fig. 1.) (*Photograph taken by the Photographic Division.*)

The fields x storage interaction was due to the exceptional behavior of the Bongabon bulbs which showed a lower percentage of sprouting in cold storage than in common storage.

The months x storage interaction is due to the fact that in cold storage there was a low amount of sprouting during the third and the fourth months when there was a marked increase; this was contrasted with common storage where there were consistent increases over the period studied.

The treatment x months interaction was due to the fact that the higher MH treatments showed a steady increase in amount of rotting throughout the period of the experiment whereas the control and lower MH treatments tended to level off. The field x months interaction was due to a very low rate of rotting in Bongabon during the first month but this increased until it was almost as great as that of the other location by the fourth month. The treatment x storage interaction was due to the fact that at higher MH treatments cold storage was not able to suppress rotting as it did at the lower MH treatments.

Los Baños Experiment

Effect of "grades" on sprouting and rotting. Differences in sprouting among grades were not significant (table 3). The large mature grade had the highest percentage of rotting. However, differences were not significant for either the sprouting or rotting (table 4).

Effect of MH treatment on sprouting and rotting. Although there were no significant differences among the MH treatments, it is noteworthy that the control is lower in the mean percentage of sprouting than in any of the MH treatments except the 10,000 ppm (toothpick). These results appear similar to those of Paterson (1952) who found that certain low concentrations of MH applied shortly before harvest stimulated sprouting. More rotting was noted at high concentrations.

Effect of time in storage on sprouting and rotting. Time had a highly significant effect on sprouting and rotting. As in the Nueva Ecija experiments, sprouting was low during the first two months but increased rather markedly in the third month. Approximately 50% of the bulbs in the entire experiment rotted during the first month.

TABLE 3.—*Cumulative average monthly sprouting in per cent, Los Baños experiment*

GRADES	MONTHS	CHECK	2500 (paint)	5000 (paint)	10000 (paint)	10000 (thpck)	MEAN
Large mature	M1	4	12	0	0	7	4.6
	M2	7	20	3	3	7	8.0
	M3	7	20	3	7	7	8.8
	Mean	6.0	17.3	2.0	3.3	7.0	
Large green	M1	0	7	0	19	0	5.2
	M2	0	7	8	19	0	6.8
	M3	7	14	17	25	8	14.2
	Mean	2.3	9.3	8.3	21.0	2.7	
Medium mature	M1	7	0	0	0	0	1.4
	M2	7	8	10	3	0	5.6
	M3	19	8	26	3	0	11.2
	Mean	11.0	5.3	12.0	2.0	0	
Medium green	M1	5	0	12	9	0	5.2
	M2	14	0	18	9	0	8.2
	M3	19	5	18	9	0	10.2
	Mean	12.7	1.7	16.0	9.0	0	
Small mature	M1	0	7	0	3	3	2.6
	M2	7	14	4	6	3	6.8
	M3	19	14	15	16	3	13.4
	Mean	8.7	11.7	6.3	8.3	3.0	
Mean		8.1	9.1	8.9	8.7	2.5	

SMD (T) at 5% = 2.233
1% = 2.996

Discussion

The results of the Nueva Ecija experiments confirmed those of various other workers, viz., sprays of MH applied at about two weeks before harvest are effective in inhibiting sprouting in storage without hindering growth during the last two weeks in the field. That not all bulbs were inhibited from sprouting even during the first month, is probably due to the fact that some bulbs at the time of spraying did not have any green foliage through which MH absorption could take place.

In common storage MH-treated bulbs rotted more readily than untreated bulbs. This was true with all MH treatments whether applied to green plants, newly harvested bulbs or partly cured bulbs. It would appear that pathogens present on or in the bulbs are able

TABLE 4.—*Cumulative average monthly rotting in per cent, Los Baños experiment*

GRADES	MONTHS	CHECK	2500 (paint)	5000 (paint)	10000 (paint)	10000 (thpck)	MEAN
Large mature	M1	37.0	36.0	55.0	63.0	62.0	50.6
	M2	59	52	74	83	83	70.2
	M3	85	56	84	87	90	80.4
	Mean	60.3	48.0	71.0	77.6	78.3	
Large green	M1	43	43	42	31	85	48.8
	M2	79	57	67	44	92	67.8
	M3	79	71	67	50	92	71.8
	Mean	67.0	57.0	58.7	41.7	89.7	
Medium mature	M1	30	54	26	63	100	54.6
	M2	48	67	45	70	100	66.0
	M3	52	71	55	87	100	73.0
	Mean	43.3	64.0	42.0	73.3	100	
Medium green	M1	24	45	53	59	85	53.2
	M2	33	50	71	64	95	62.6
	M3	36	73	76	73	100	71.6
	Mean	31.0	56.3	66.6	65.3	93.3	
Small mature	M1	26	28	23	38	93	41.6
	M2	33	41	27	47	93	48.2
	M3	56	55	38	69	97	63.0
	Mean	38.3	41.3	29.3	51.3	94.3	
Mean		48.0	53.3	53.5	61.9	91.1	

SMD (T) at 5% = 3.816
1% = 5.121

to become established better in bulbs whose physiology has been altered by MH. However, in cold storage there were no significant differences in rotting between treated and untreated lots.

Data from these experiments indicate that MH is disadvantageous in common storage since the bulbs rotted.

In these experiments considerable attention was given to bulb applications rather than to green plant applications. Dipping the bulbs in the field gave the same control of sprouting as the conventional green-plant application. Furthermore, trimming the root plate of the bulbs just prior to dipping so that succulent absorbent tissue would be subjected to the MH further increased effectiveness. Data show, however, that all the advantages of this method are offset by the greater amount of rotting.

Since rotting was very severe in the preliminary experiment on partly cured bulbs further study is needed to determine whether MH applied to such bulbs can control sprouting.

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* * *

One of the only two articles that remain in my creed of life is that the future of our civilization depends upon the widening spread and deepening hold of the scientific habit of mind; and that the problem of problems in our education is therefore to discover how to mature and make effective this scientific habit. The other . . . is faith in democracy as a social mode of life.

—*John Dewey*

DEMONSTRATION OF LIMITED EPISTASIS IN MAIZE[1]

I. S. Santos, H. L. Everett, and F. A. Aquilizan

The determination of genotype (with respect to the waxy locus) of the plant through an iodine test of the pollen grains was found to be about 85 per cent accurate when compared to an iodine test of the kernels in the selfed ear of the same plant.

There are numerous genetic variations in the carbohydrate constitution of the maize endosperm. One recessive gene, *su* is responsible for the difference in appearance and composition between the sweet-corn kernel and other types of corn kernels (Hayes *et al.*, 1955). This gene prevents the conversion of part of the sugar into starch. A second gene, *wx*, which is independent of and non-allelic to the first, influences the type of starch formed. Starch from waxy glutinous (wxwx) corn differs from ordinary dent or flint starch in both molecular structure and pasting characteristics. The molecular structure of the starch from glutinous varieties is characterized by a completely branched chain (amylopectin) whereas that of the starch from the kernel of the other types of maize has a high percentage of straight-chain molecules (amylose). Pastes made from waxy starch are translucent and flavorless, while pastes from ordinary starch are opaque and have a distinctive flavor (MacMasters and Hilbert, 1944). The development of corn varieties suitable for specific industrial use, and which differ in carbohydrate content quantitatively and qualitatively, has been the object of considerable research (Dunn *et al.*, 1953; Deatherage *et al.*, 1954; Sprague, 1955).

Studies have shown that the quantity and quality of the carbohydrate content of the corn kernel have much to do with the type of green corn preferred. Brunson and Escarlos (1956) reported that sweet corn types are preferred to all other types as boiled green corn. Further studies conducted by the authors indicate that locally, glutinous corn is preferred to other forms. It thus appears that if these two genes, *su* and *wx* are combined in a single corn variety,

[1] Central Experiment Station Contribution No. 1936. A part of the project on the development of sugary-waxy corn varieties. Performed by the members of the class, Agronomy 107 (Advanced Plant Breeding), first semester 1956-57, under the direction of the senior authors.

the eating quality of such a variety might appeal to the taste of a great majority.

Part of this project of developing a desirable sugary-waxy corn variety proved adaptable as a laboratory project for a course in advanced plant breeding. It demonstrated to the advanced plant breeding class how knowledge of plant genetics can facilitate work in a plant breeding project.

MATERIALS AND METHODS

Hawaii Yellow Sweet and Morong White Glutinous were chosen as the initial breeding materials because both varieties are productive and have good eating quality.

Crosses between the two parental stocks were made in the dry season of 1953-54 (November, 1953 to March, 1954). The F_1 plants were grown and self-pollinated in the dry season of 1955-56.

Kernels in the ears from the selfed F_1 plants were classified into *starchy, waxy,* and *sugary.* The following factor pairs were used:

Su = Non-sugary endosperm
su = sugary endosperm
Wx = Non-waxy endosperm
wx = waxy endosperm

The genotypes and corresponding phenotypes were as follows:

Su... Wx.... = starchy
Su.... wxwx = waxy
susu Wx..... = sugary
susuwxwx = sugary

Only the sugary (wrinkled) kernels were planted by the students. These plants were intended to serve as materials for the demonstration of limited epistasis in corn. The pollen grains of these plants were studied for their reaction to iodine. At sexual maturity, these plants were selfed and kernels from each ear were tested with iodine.

Epistasis may be defined as the dominance of a gene over one or more genes which are non-allelic to the "dominant" gene. In corn, the sugary gene, *su,* is epistatic to the waxy gene, *wx.* Hence, the genotype *susuwxwx* exhibits only the wrinkled, semi-transparent kernel reflecting the presence of the recessive gene *su* in the homozygous condition, but it does not exhibit the ivory white (opaque) or "ivory" yellow appearance of the endosperm that indi-

cates the presence of the recessive gene, *wx*, in the homozygous condition. Hence, the genotypes *susuWxWx*, *susuWxwx*, and *susuwxwx* have identical phenotypic expression. The epistatic effect of the gene *su* on the gene *wx*, however, is present only as far as the actual appearance of the corn kernel is concerned. The use of an iodine solution of proper concentration [2] can show that the kernels of the genotypes *susuWxWx* and *susuWxwx* can be distinguished from the kernels of the genotype *susuwxwx*. The genotype of the parent plant with respect to the *Wx* vs. *wx* locus can then be deduced. This is called *limited epistasis*.

Similarly, with the iodine test, the genotype of the "gamete" (pollen) with respect to the *Wx* vs. *wx* locus can also be determined. In this experiment, determination of the plant genotype through iodine test of the pollen was compared with that determined through the iodine test of the kernels in the selfed ear of the same plant.

The plant genotype was determined by an iodine test of the pollen in the following manner: Plants whose pollen grains stained bright red were classified as genotype *susuwxwx*; plants whose pollen grains stained dark blue or black were classified as genotype *susuWxWx;* and plants that produced pollen grains about 50% of which stained bright red and about 50% dark blue or black were classified as genotype *susuWxwx*.

The plant genotype was also determined by an iodine test of the kernels in the selfed ear in the following manner: Plants that yielded selfed ears whose kernels stained red were classified under genotype *susuwxwx;* plants that yielded selfed ears whose kernels stained dark blue were classified under genotype *susuWxWx;* and plants that yielded selfed ears with 75% of the kernels stained dark blue and only about 25% red were classified under genotype *susuWxwx*.

EXPERIMENTAL RESULTS

Kernel classification in selfed F_1 ear. Table 1 gives the kernel classification in the selfed F_1 ears of the cross between Morong White Glutinous and Hawaii Yellow Sweet.

Only five student groups were able to follow the procedure up to the determination of the genotype of the sweet-corn plants with

[2] Strong KI—I_2 solution—0.3 gm. I_2; 1.0 gm. KI; and 100 c.c. H_2O.
For classifying waxy in sugary seeds, the undiluted strong solution was used.
For classifying pollen, the strong solution was diluted with an equal volume of tap water.

TABLE 1.—*Segregation data from the selfed F_1 ears of a cross between Morong White Glutinous and Hawaii Yellow Sweet*

STUDENT GROUP NO.[a]	STARCHY	WAXY	SUGARY	TOTAL	INDIVIDUAL CHI-SQUARE VALUES
1	203	47	82	332	5.15 [b]
2	204	51	105	360	6.54 [b]
3	244	68	131	443	6.53 [b]
4	172	47	73	292	1.46
5	221	67	86	374	1.26
Total [c]	1044	280	477	1801	
Proposed ratio	9	3	4		

[a] Student group #1 was composed of C. Molinyawe and L. Marquez; #2, S. I. Albano, F. A. Aquilizan, R. K. Palis, and A. de Mesa; #3, G. Romanes and S. Masajo; #4, U. Champhaka and A. Obligado; and #5, D. Herrera and M. Rivera.

[b] Differs from proposed ratio at 5% level.

[c] For total: $x^2 = 12.40$ d.f. $= 2$ $P < 0.01$

respect to the *Wx* vs. *wx* locus. Hence, only the segregation data from the selfed F_1 ear obtained by these five student groups are shown in this table.

Deviations of the observed counts from the expected, indicated that there was a deficiency of waxy (glutinous) kernels. When counts were accumulated from the five maize ears these deviations were found to be highly significant.

Table 2 shows the results of the determination of genotype by the iodine test of the pollen of S_2 sweet corn segregates and the S_3 kernels produced by the selfing of these S_2 plants. The classification of 27 plants studied based on pollen and kernel analyses both indicated a good fit to a 1 *WxWx* : 2 *Wxwx* : 1 *wxwx* ratio. However, there were five cases wherein the results of the pollen and of kernel analyses did not agree. By kernel analysis Plant Nos. CM-14 and MR-9 were classified under genotype *susuWxWx;* by pollen analysis these same plants were classified under genotype *susuwxwx.* Plant Nos. CM-27 SM-18 were both classified under genotype *susuWxwx* by kernel analysis; *susuwxwx, by pollen analysis.* In these four cases some or all the pollen grains were classified as carrying the *wx* gene when they did not actually carry it as shown in the kernel analysis. On the other hand, AM-7 was determined to have the genotype *susuWxwx* by kernel analysis and yet it was classified under genotype *susuWxWx* by pollen analysis. Here, the waxy gene escaped detection in the pollen grain.

TABLE 2.—*Determination of genotype by iodine test of pollen of S_2 sweet-corn segregates and the S_3 kernels from the cross between Morong White Glutinous (SuSuwxwx) and Hawaii Yellow Sweet (susuWxWx)*

STUDENT GROUP NO.	PLANT NO.	POLLEN ANALYSIS	KERNEL ANALYSIS
1	CM-14	wxwx [a]	WxWx
	CM-20	Wxwx	Wxwx
	CM-24	Wxwx	Wxwx
	CM-27	wxwx [a]	Wxwx
2	AM-3	Wxwx	Wxwx
	AM-7	WxWx [a]	Wxwx
	AM-12	Wxwx	Wxwx
	AM-26	wxwx	wxwx
	AM-27	Wxwx	Wxwx
	AM-31	Wxwx	Wxwx
	AM-39	Wxwx	Wxwx
3	SM-4	wxwx	wxwx
	SM-6	WxWx	WxWx
	SM-14	WxWx	WxWx
	SM-17	wxwx	wxwx
	SM-18	wxwx [a]	Wxwx
	SM-20	wxwx	wxwx
	SM-22	WxWx	WxWx
	SM-25	wxwx	wxwx
	SM-29	Wxwx	Wxwx
	SM-34	WxWx	WxWx
4	ON-1	Wxwx	Wxwx
	ON-2	Wxwx	Wxwx
	ON-17	Wxwx	Wxwx
5	MR-3	wxwx	wxwx
	MR-9	wxwx [a]	WxWx
	MR-10	Wxwx	Wxwx

[a] Pollen analysis and kernel analysis did not agree.

DISCUSSION AND CONCLUSION

Comparing results of the iodine test of the pollen as a means of determining genotype with respect to the *Wx* vs. *wx* locus with those obtained by iodine test of kernel showed that the former can be used for such purpose. When compared to kernel analysis, pollen analysis was found to be not 100 per cent accurate. In the first attempt, however, an accuracy of 85 per cent was obtained. With this accuracy, the determination of genotype by pollen analysis will be a useful tool in selecting plants of particular genotypes for the *Wx*

vs. *wx* locus for use in crossing and selfing. The authors are confident that with improvement in technique with regard to the concentration of iodine solution, age of anthers (and of pollen grains), and amount and quality of light in the microscope, a better percentage of accuracy can be obtained. Experience of the researcher with the technique can also increase its accuracy.

Several problems related to this experiment remain as part of the project of developing a desirable sugary-waxy corn variety for use in the Philippines. A few of these problems may be undertaken as laboratory projects in future advanced plant breeding classes. For example, future classes may find why determination of genotype by pollen analysis is not 100 per cent accurate; why glutinous (waxy) kernels are fewer than expected in the segregating ears. Such classroom researches will serve as a teaching aid of great importance and at the same time contribute information that will facilitate the project.

Sweet corn lines differing in genotype with respect to the waxy vs. non-waxy locus have been isolated. These will be used for synthesizing sweet corn varieties that differ in the type of starch found with sugars. When these varieties are synthesized they will be presented to taste panels for judgment as to eating quality.

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It is of no purpose to discuss the use of knowledge. Man wants to know and when he ceases to do so, he is no longer man.

—*Fridtjof Nansen*

RESPONSE OF RAMIE TO AMMONIUM SULFATE FERTILIZATION IN THE FIRST HARVEST AND IN THE FIRST, SECOND AND THIRD RATOONS [1]

FLORENTINO B. LAGAN and ERNESTO A. RAPISTA

WITH ONE TEXT FIGURE

Saikeiseisin, a variety of ramie (*Boehmeria nivea* Linn.), fertilized with ammonium sulfate at the rates of 90, 135, 180, 225, 270, 315, and 360 kilograms to a hectare, tended to grow taller as the amount of fertilizer was increased. The application of ammonium sulfate had no pronounced effect on the branching of the stems. All the treated plots yielded significantly more fibers and more stools than the control. The rate of fertilization did not significantly affect the tensile strength of the fiber.

Ramie or china grass (*Boehmeria nivea* Linn.) is one of the promising fiber crops of the Philippines. It can be grown in almost any soil, but it is only through proper fertilization that the crop has been able to increase its yield to more than double.

Goulding (1919)[2] found that ramie plants remove a considerably large amount of nutrients from the soil. Since only a small proportion of these nutrients is contained in the fiber, it is advantageous to return much of the harvest refuse of the crop to the land. He also found that without liberal manuring, the yield of fiber diminishes.

David (1939)[3] observed that ramie responds readily to the fertility of the soil and to fertilization. Although this plant is usually grown on rich soil in Davao, a certain amount of fertilizer is applied to guard against a decrease in yield particularly in the succeeding crops. Ammonium sulfate is applied to ramie plantations in Davao at the rate of 200 kilograms to a hectare.

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[1] Central Experiment Station Contribution No. 1937. Based on theses presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March and October, 1956. Prepared in the Department of Agronomy under the direction of Dr. Jose R. Mondoñedo, Messrs. Manuel Perigua and Laureano Bondoc, and in the Department of Soils under the direction of Dr. Nicolas L. Galvez.

[2] C. E. Goulding, "Cotton and Other Vegetable Fibers", John Murray, London, 1919, p. 241.

[3] P. A. David, *Philippine Agriculturist*, 28, 72 (1939).

Robinson (1946)[4] reported that poor yields are always obtained from ramie crops in the second year and thereafter, unless the fertility of the soil is maintained in some way. Cruz (1946)[5] suggested that to increase fiber yield ramie plantations should be fertilized or top-dressed annually with commercial fertilizer, preferably ammonium sulfate.

Daza (1951)[6] found that application of ammonium sulfate had no effect on the branching of ramie plants but gave significantly higher yield in dry fiber than the unfertilized plants.

This study was conducted from January, 1955 to September, 1956, in the Fiber and Oils Division of the Department of Agronomy to obtain more information on the effect of varied amounts of nitrogen on the yield of ramie.

MATERIALS AND METHODS

Sufficient amount of soil was collected from different parts of a 225-square-meter field adjacent to the Agronomy Main Building. The soil was air-dried, pulverized and screened through a 2-millimeter sieve. Analysis[7] showed that it contained 0.24 per cent total nitrogen, 58.28 milligrams available phosphorus per 100 grams of soil, 0.01 per cent of soluble potassium (K_2O), and a pH value of 5.67.

On January 31, 1955 this field was plowed by a tractor and then harrowed one week later. At the close of the dry season, it was replowed three times by a native plow, each plowing followed by harrowing. The field was divided into four blocks. Each block was subdivided into eight plots, each plot consisting of three furrows 80 centimeters apart.

On May 29, 1955, rootstocks of Saikeiseisin were cut 25 centimeters long and planted the following day. Six rootstocks were set 40 centimeters apart in each row. Each rootstock was planted in a slanting position with one-third of its length above the ground. Two weeks after germination, all vacant hills were replanted.

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[4] B. B. Robinson, *U.S. Dept. Agric. Cir. 585* (1946).
[5] E. E. Cruz, *Phil. Dept. Agric. and Comm. News Bull.* (1946).
[6] D. M. Daza, *Philippine Agriculturist*, 35, 59 (1951).
[7] Conducted by S. Sanchez of the Department of Agricultural Chemistry.

The fertilizer treatments were as follows:

TREATMENT NO.	AMOUNT OF AMMONIUM SULFATE IN KGMS.
1	Control
2	90
3	135
4	180
5	225
6	270
7	315
8	360

One-half of the fertilizer was applied in the furrows a day after planting and the other half as side dressing, when the plants were 40 days old. In the first, second and third ratoons, one-half of the fertilizer was applied one week after harvesting and the other half at the age of 40 days as side dressing.

The plants were weeded after the third week following planting. This was followed by cultivation and hilling up with a grub hoe. Weeding was stopped when the plants were almost knee-high.

The plants were ready for harvest when about one-third of the stem had turned brown and one-half of the flower cluster had withered. The first ratoon crop was harvested 90 days after planting, the second crop at 68 days of age and the third at 75 days of age. The plants were cut close to the ground and then bundled.

A Mayon ramie decorticator was used to extract the fiber. The machine had a number of steel knives with edges that held and pulled the stalks inwardly, scraping them against an iron block, breaking the weed and removing the pulp. Three or four stalks were fed at a time to the receiver and the fiber ribbons were pulled off. The same process was done for the undecorticated basal ends. In order to obtain clean fiber, feeding and withdrawing of the stalks were done slowly.

After being decorticated the fibers were washed and cleaned thoroughly with water to remove the adhering dirt, pulp, wood, and other foreign materials. Then they were hung on a rack to dry after which the dry weights were taken separately according to treatments.

The formula of Botkins, Shires, and Smith [8]:

$$\text{Tensile strength} = \frac{\text{Breaking load}}{\text{Weight of sample per centimeter}}$$

was used to determine the tensile strength (expressed in breaking length) of the fiber. The breaking load of single-fiber strands was determined by the Scott Tester IP-2 Tensilegraph machine. Ten trials were made for fibers harvested from each plot.

RESULTS AND DISCUSSION

General appearance of the plants. Differences in appearance of the plants were noted only when the plants had fully developed leaves. Distinct differences in growth were observed when the plants were about to mature. The fertilized plants had more flower clusters, darker green leaves and better growth than the unfertilized plants.

Similarly, in the second and third ratoon crops, the fertilized plants produced darker leaves and more flower clusters than the control. In both crops the fertilized plants were much better than the control. Mean data on results are given in the summary table at the end of this article.

Number of stalks. The number of stalks to a hill in the different treatments varied significantly. This variation indicates that the application of ammonium sulfate significantly influenced the stooling power of the plants. The highest mean number of stalks was obtained from the plants fertilized at the rate of 360 kilograms to a hectare and the lowest from the unfertilized plots. Number of stalks to a hill tended to increase as the rate of application increased.

Height of plants. The application of ammonium sulfate influenced the height of the plants significantly. The average height of plants in the fertilized plots ranged from 115.7 to 149.1 centimeters, whereas that of the untreated plot was 11.2 centimeters. For every increase in the rate of application, there was a corresponding increase in the height of plants.

In the second and third ratoons, plots treated with 315 kilograms to a hectare produced the tallest plants with an average height of

[8] C. W. Botkin, C. B. Shires, and E. C. Smith, *New Mexico Agric. Exper. Sta. Bull.* 300 (1943).

146.5 centimeters. The unfertilized plants were the shortest with a mean height of 75.5 centimeters. In general, the higher rates of nitrogen application tended to produce taller plants.

Number of plants that branched. The application of ammonium sulfate did not influence branching in any of the ratoon crops. There were very few plants that branched; most of the plots had only one and the distribution to the treatments was almost equal. This condition is advantageous. Unbranched stalks are desired in any fiber crop, because at the junction of the main stem and its branch, fiber strands discontinue. This makes extraction difficult and result in short and weak fibers.

Weight of dry fiber. The weight of fibers produced by the fertilizer treatments tended to differ significantly from the control. Only the difference between the 90-kilogram treatment and the control was not significant. The plots treated with 360 kilograms to a hectare gave the greatest amount of dry fiber per hill and the control gave the least yield of dry fiber. The average yield of the fertilized plants ranged from 7.8 to 14.8 grams to a hill; the control gave an average of 6.7 grams. The average increases in weight of the plant from the different treatments over the control were as follows: treatment 2, 1.1 grams; treatment 3, 3.8 grams; treatment 4, 4.2 grams; treatment 5, 4.8 grams; treatment 6, 5.5 grams; treatment 7, 5.6 grams; and treatment 8, 8.1 grams. The mean difference significant at 5% level was 2.43 grams.

The yield of the first ratoon was almost twice that of the first harvest. This was probably because the mother rootstocks had already been established and did not have to recover from adverse effects of planting; hence, they were more prolific in the production of stools. The plants fertilized with 360 kilograms to a hectare again gave the highest yield with an average of 22.8 grams to a hill. The unfertilized plots gave the lowest yield with an average of 10.7 grams to a hill (fig. 1). This indicates that with an increase in the application rates, there is a corresponding increase in yield.

In the second ratoon crop the yield in dry fiber per hill of the fertilized plot, except treatment II, was significantly higher than that of the unfertilized plots. The average dry weight of fiber per hill in the fertilized plots ranged from 7.87 to 14.25 grams in favor of plots receiving more fertilizer. This shows that for every increase in the

Fig. 1—*Fiber yield to a treatment in the first ratoon.* (1) Control (2) applied with 90 kg., (3) 135 kg., (4) 180 kg., (5) 225 kg., (6) 270 kg., (7) 315 kg. (8) 360 kg. (Photograph taken by the Photographic Division.)

amount of fertilizer applied, there was a corresponding increase in the yield of dry fiber.

Similarly, in the third ratoon crop, the fertilized plots produced significantly higher yields in dry fiber than the unfertilized plots. The yield of unfertilized plots averaged 9.55 grams of dry fiber per hill while those of the fertilized plots ranged from 14.60 to 22.70 grams.

Attack of pests and diseases. One month after planting, the caterpillars of *Plusia chalcytes* Exper. (Noctuidae, Lepidoptera) and

the larvae of *Sylepta sabinusalis* Walker (Pyralidae, Lepidoptera)[9] were observed feeding on the leaves of the plants. All the treatments were equally affected; however, the attack was not alarming enough to warrant any means of control. The damage caused by *Sylepta sabinusalis* was greater than that caused by *Plusia chalcytes*. The former produced rolling of the leaves. These pests were present in the first, second and third ratoon crops, with practically the same degree of infestation.

When the plants were about to mature, infection with *Cercospora boehmeriana* Wor.[10] was observed. It attacked the young leaves of the plants from the leaf apex to the base. At the advanced stage the leaf turned yellow, curled and withered. All the treatments were equally affected; however, the damage was not severe enough to call for immediate remedial measure.

Tensile strength of the fiber. The 315-kilogram treatment produced the strongest fiber in the first harvest. The weakest fibers were produced by the control in both harvests. Differences between the fertilized treatments and the control in the first harvest, however, were not significant, whereas those in the first ratoon were significant. These insignificant differences in the first harvest must have been due to delay in the determination of fiber strength, which should have been done immediately after the fibers had dried instead of about two months later. The fiber cells must have been affected by the loss of moisture.

In the second and third ratoons, the tensile strength of the fibers was determined after they had dried. The plants fertilized with 360 kilograms of ammonium sulfate to a hectare produced the strongest fibers.

However, differences in tensile strength between treatments were not significant, showing that the amount of fertilizer had no effect on the tensile strength of fibers produced.

[9] These insects were identified by Dr. S. M. Cendaña of the Department of Entomology.

[10] Identified by Prof. V. M. Ela of the Department of Plant Pathology.

SUMMARY TABLE

Response of ramie to ammonium sulfate fertilization in the first harvest and in the first, second, and third ratoons

A. *First Harvest*

TREATMENT	STALKS/HILL	HEIGHT OF PLANT IN CM.	BRANCHED STALKS PER PLOT	DRY FIBER YIELD IN GM./HILL	TENSILE STRENGTH OF FIBER IN KM.
	mean	*mean*	*mean*	*mean*	*mean*
Control	3.2	111.2	1.0	6.7	17.5
90	3.9	115.7	1.7	7.8	17.7
135	4.0	134.6	1.5	10.5	18.3
180	4.2	137.1	1.0	10.9	18.3
225	4.2	142.7	1.5	11.5	18.8
270	4.3	146.5	0.7	12.2	19.1
315	4.4	146.7	0.7	12.4	19.5
360	4.5	149.1	0.7	14.8	19.2
SMD (5%) = .46			= 13.71	Insig.	= 2.43
SMD (1%) = .62			= 18.65		= 3.31

B. *First Ratoon*

TREATMENT	STALKS/HILL	HEIGHT OF PLANT IN CM.	BRANCHED STALKS PER PLOT	DRY FIBER YIELD IN GM./HILL	TENSILE STRENGTH OF FIBER IN KM.
	mean	*mean*	*mean*	*mean*	*mean*
Control	6.7	118.8	0.5	10.7	18.9
90	8.3	126.6	0.5	14.6	19.7
135	8.9	134.3	0.5	15.5	19.8
180	9.3	141.2	3.7	16.1	21.3
225	9.3	145.3	1.0	18.3	21.5
270	9.5	146.1	0.2	20.1	21.9
315	9.8	146.5	0.7	21.1	22.0
360	9.7	145.3	0.2	22.8	23.0
SMD (5%) = 1.22		= 9.85	Insig.	= 3.64	= 1.37
SMD (1%) = 1.66		= 13.42		= 4.95	= 1.86

C. *Second Ratoon*

TREATMENT	STALKS/HILL	HEIGHT OF PLANT IN CM.	DRY FIBER YIELD IN GM./HILL	TENSILE STRENGTH OF FIBER IN KM.
	mean	*mean*	*mean*	*mean*
I (Control)	5	78.9	6.28	17.6
II (90)	7	89.5	7.87	17.6
III (135)	7	94.5	10.30	18.2
IV (180)	7	95.2	11.80	18.3
V (225)	8	96.6	11.0	18.7
VI (270)	8	97.4	12.22	18.8
VII (315)	8	102.0	13.35	19.1
VIII (360)	8	103.0	14.25	19.2

D. *Third Ratoon*

TREATMENT	STALKS/HILL	HEIGHT OF PLANT IN CM.	DRY FIBER YIELD IN GM./HILL	TENSILE STRENGTH OF FIBER IN KM.
	mean	*mean*	*mean*	*mean*
I (Control)	3	75.5	9.55	17.3
II (90)	4	85.6	14.60	17.6
III (135)	4	88.9	15.48	17.9
IV (180)	5	93.2	16.18	18.0
V (225)	5	97.7	18.16	18.1
VI (270)	5	98.2	19.82	18.1
VII (315)	6	102.4	21.62	18.0
VIII (360)	5	103.6	22.70	18.5

* * *

Mature scholars working together for the development and utilization of knowledge form the foundations of our civilization. Few things can be more important than to enhance and maintain the dignity of the investigator's profession so as to attract into its ranks men of highest ability, of sound learning, and of strong independent character. Such men have special obligations to one another, to their institution, and to the public.

—*A. J. Riker, M. R. Irwin, R. J. Muckenhirn, H. Parsons, and M. G. Schaars*

ELECTRON MICROSCOPY OF THE UNPURIFIED EXTRACTS OF COCONUT INFECTED WITH THE CADANG-CADANG DISEASE [1]

G. O. Ocfemia and Antonio D. Bustrillos [2]

WITH TWO PLATES

The symptoms of the coconut cadang-cadang disease and its method of spread in the field leave little doubt that the disease is caused by virus. The diagnosis of the disease was made by the senior author in 1931 [3] in the property of the Agusan Coconut Company adjoining the coconut plantation of a Mr. Taylor on San Miguel Island, Tabaco, Albay where the cadang-cadang disease first appeared.

Before transmission of the virus is demonstrated, evidence for its presence was sought by examination with the electron microscope, juices from opened leaves, unopened leaves, unopened spathes, and cabbages of infected coconuts to see if foreign bodies can be distinguished from the sap which are not present in similar preparations from healthy plants.

MATERIALS AND METHODS

The materials consisted of opened and unopened leaves, cabbages, and unopened spathes of cadang-cadang infected coconuts. The specimens were collected by the writers from the Cadang-Cadang Research Station of the Bureau of Plant Industry, Guinobatan, Albay, on December 27, 28 and 29, 1956 with the cooperation of Mr. Avelino R. Bigornia, Entomologist, and Mr. Carlos A. Calica, Plant Pathologist of the Cadang-Cadang Station. As checks, corresponding parts of supposedly healthy palms from the Cadang-Cadang Station and neighborhood and opened leaves, unopened leaves, and unopened spathes of three healthy trees from the College of Agriculture were collected.

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[1] Central Experiment Station Contribution No. 1938. Read by the senior author before the Cadang-Cadang Conference sponsored by the Bureau of Plant Industry in cooperation with the U.P. College of Agriculture, held in the Cadang-Cadang Research Station, Banao, Guinobatan, Albay, March 18, 1957.

[2] Professor of Plant Pathology, College of Agriculture, and Electron Microscopist, Central Experiment Station, respectively.

[3] G. O. Ocfemia, *Philippine Agriculturist*, 26, 338 (1937).

Part of the specimens collected from Guinobatan were cut into pieces with a knife and then ground through a corn mill at the Coconut Cadang-Cadang Laboratory. The juices were expressed manually through clean cheesecloth. A small amount of distilled water was added to the ground leaves because they had little juice. The extracts and the unground parts of the specimens were placed in a refrigerator, and kept there until they were transported to the College of Agriculture at Los Baños.

Preparation of the specimen for electron microscopy

The frozen extracts were allowed to thaw and were clarified through three 30-minute centrifugations in an International Micro Centrifuge at about 1800 rpm. to throw down at least some of the plant debris. The specimens for electron microscopic examination were taken from each sample after the third centrifugation. In no case were the samples allowed to remain long at room temperature. They were always kept at low temperature except during the extraction of the juice and its centrifugation.

Sterile medicine droppers with fine nozzles were used in transfering the samples to the formvar film-coated-specimen carriers. A small drop of the clarified juice was placed on the surface of a film-coated-specimen carrier and allowed to come in contact with the film for about 30 seconds. With a small strip of filter paper, the excess drop was withdrawn as completely as possible by touching the edge of the carrier, and the preparation was allowed to dry in a Petri dish. These preparations were examined in the electron microscope.

Preparation of the film-coated-specimen carrier

The supporting membrane for the specimen was a "formvar" film,[4] grade no. 15/95E. A 1.4 per cent solution of formvar in ethylene chloride was prepared and allowed to stand overnight. This concentration was sufficiently thin though strong enough to support the specimen for electron microscopy.

A 200 per inch Lectromech screen [5] previously cleaned with ether was used as film support.

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[4] "Formvar"—a trade name of a group of thermoplasmic resin manufactured by Shawinigan Products Corporation, New York 1, N.Y., U.S.A.

[5] Lectromech—a trade name for an electroplated grid of nickel or copper manufactured by C. O. Jelliff Mfg. Corp., Southport, Conn., U.S.A.

A drop of the formvar solution was placed on the dust-free surface of distilled water contained in an 8-inch diameter moist chamber culture dish. A series of cleaned screens were placed on top of the floating film and with a clean glass slide the screens with the film on them were scooped down and lifted off the water. The excess water was blotted off by touching the black and edges of the slide with strips of filter paper. The prepared screens were placed in covered Petri dishes ready for mounting the specimens.

There were difficulties in the first films prepared because of the presence of holes. The difficulties were remedied by preparing the films in an air-conditioned room with relative humidity of 50 to 60 per cent.

Electron Microscopy

A Philips Electron Microscope, Type No. 11980/13 was used in the electron microscopic examinations and in taking electron micrographs. All examinations were made and electron micrographs taken at magnification of 11,000 times and an accelerating voltage of 40,000 to 60,000 volts. These settings were selected because at higher magnifications the specimens under observation lost contrast. All specimens were not metal shadowed.

In the electron microscopic examinations and electron micrographs (Pl. I, figs. 1-3) of unpurified extracts from healthy coconuts collected from College, Laguna, only plant debris were noted. In some cases small dense particulate bodies were observed in juices from the inflorescence of healthy palms but they were variously shaped and not uniform in size.

In addition to plant debris the unpurified extracts taken from supposedly healthy coconuts in Banao, Guinobatan, and in Parian, Camalig, Albay showed particulate bodies of low contrast to the electron beam similar to those noted in the diseased tissue extracts (Pl. I, fig. 4). The particulate bodies were observed mostly in the juices of opened leaves.

Additional evidence that virus is the cause of cadang-cadang

In spite of inadequate centrifugation, electron microscopic examinations of the unpurified juices of cadang-cadang infected coconuts collected from Banao, Guinobatan, and Camalig, Albay indicated presence of numerous uniform particulate bodies of nearly spherical shape along with the plant debris. These bodies were observed (Pl. II, figs. 6, 7 and 8) in juices from the cabbage and opened leaves.

They were more numerous in the cabbage than in the leaves (Pl. II, figs. 7 and 8). Owing to their abundance and uniformity in shape and size, they appeared suspiciously like virus particles. With these particles the writers believe that they have secured additional evidence that virus is the cause of the cadang-cadang disease of coconut. In the opened leaves (Pl. 11, fig. 6) bodies could hardly be discerned because most of them were embedded in the plant debris. High speed centrifugation to throw down most of the plant materials, metal-shadowing to bring the particles to bold relief and higher magnification should give a better picture of the virus particles.

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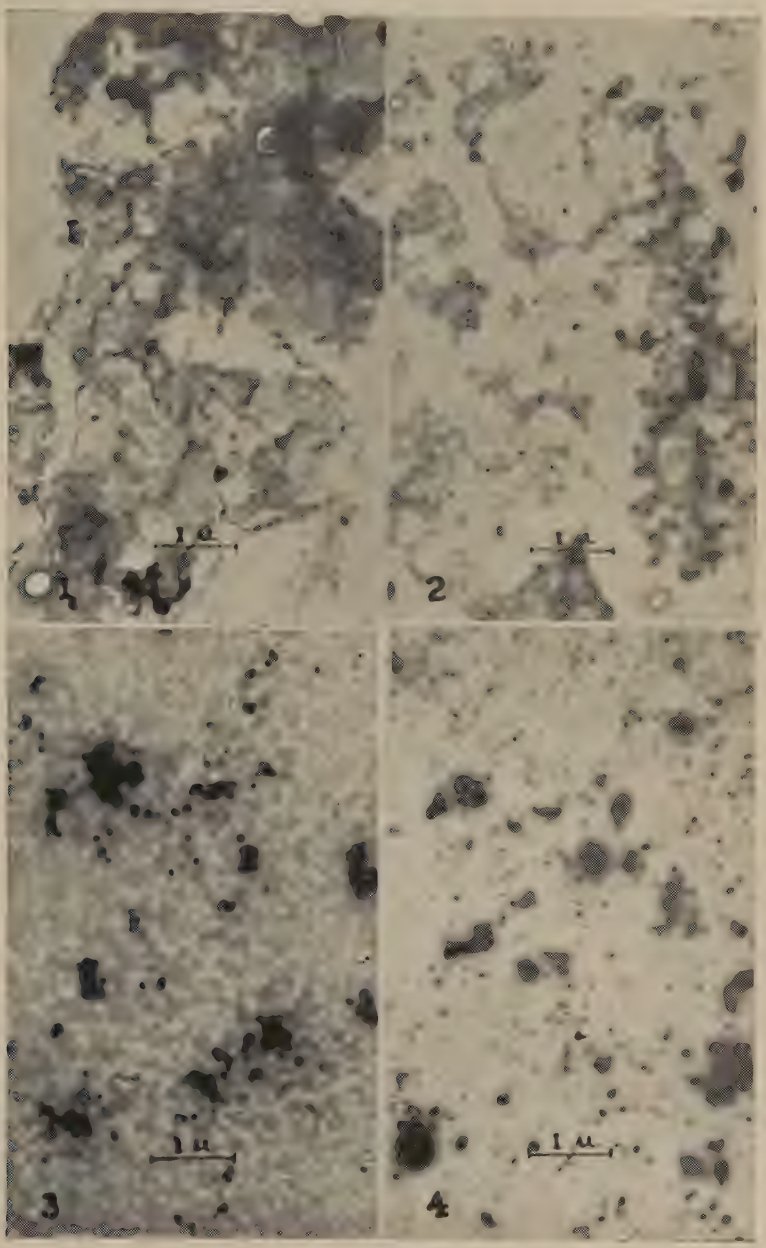

PLATE I

Electron micrographs of unpurified extracts from (1) unopened leaves, (2) opened leaves, and (3) unopened spathes of healthy coconut palms collected from College, Laguna; (4) opened leaves from supposedly healthy coconut palm collected from Parian, Camalig, Albay. All magnifications 11,000 X.

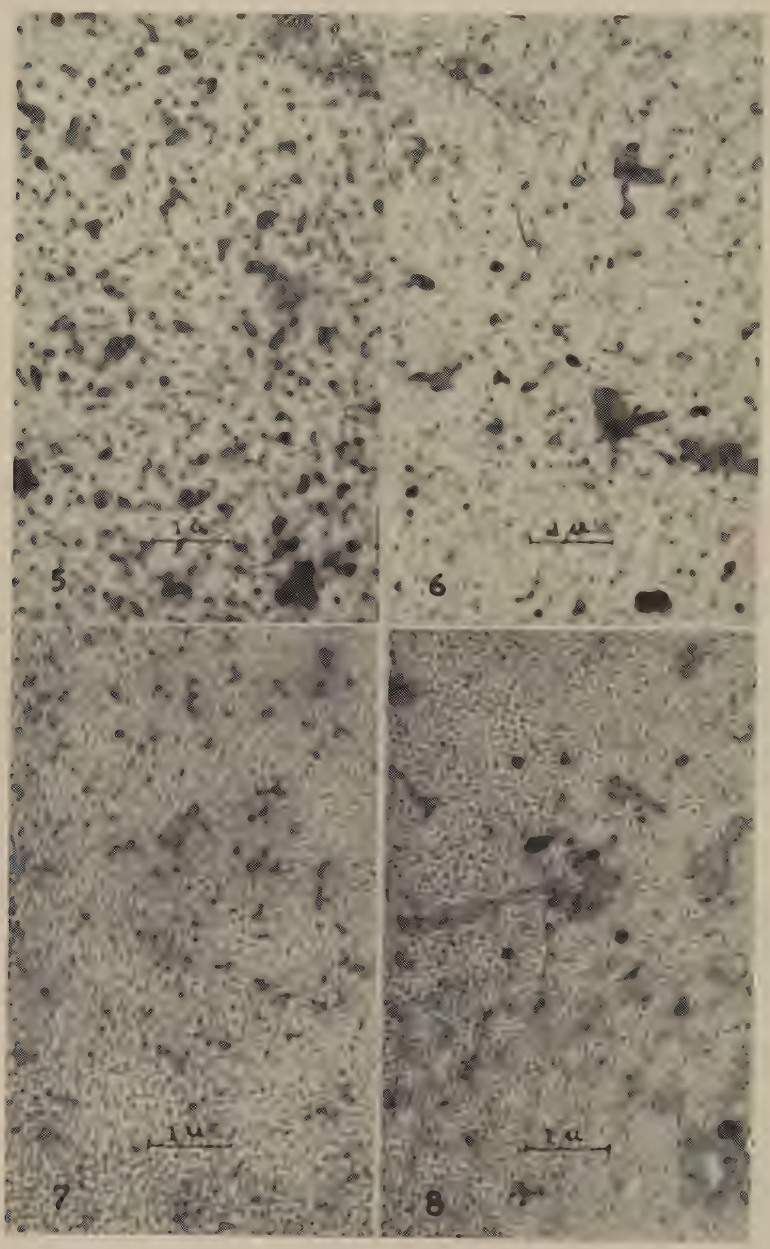

PLATE II.

Electron micrographs of unpurified extracts from (5) opened leaves from supposedly healthy palm collected from Banao, Guinobatan, Albay, (6) opened leaves from cadang-cadang infected palm collected from Banao, (7) cabbage of cadang-cadang infected palm also collected from Banao, and (8) cabbage of cadang-cadang infected coconut palm collected from Camalig, Albay. All magnifications 11,000 X.

Electron Microscope Laboratory and Photographic Laboratory, U.P. College of Agriculture and Central Experiment Station, College, Laguna.

CANE MOLASSES COMPARED WITH REFINED SUGAR IN FATTENING RATIONS FOR POULTRY [1]

FELICITAS L. CORTES and F. M. FRONDA

Cane molasses and not refined sugar may replace 26 per cent of ground corn in rations for fattening poultry when there is scarcity of corn supply. The total gain in weight of the birds and the feed conversion efficiency in the three lots of both trials did not differ markedly.

Cane molasses is an important by-product of the sugar industry. A small amount of it is used in feeding horses, cattle, swine, and poultry. Since cane molasses is a cheap by-product, and refined sugar is abundantly available, the increased use of these products may benefit sugar cane growers and sugar manufacturers. At certain seasons of the year when corn supply is limited and the price of a kilogram of the ingredient is extremely high, the addition of molasses in rations for fattening fowls may lower the cost of feeding. Cooney and Parker (1952) reported that 15 per cent molasses resulted in economical gains when added to fattening rations for broilers managed in battery equipment. Bice (1933) observed economical gains with broilers when molasses was used in fattening rations at concentrations of 5, 10, and 15 per cent of the total ration. However, the same ration resulted in inefficient production with hens confined in batteries.

Lippincott (1927) reported a slight average gain in weight of birds, and slight decrease in feed consumed when enough molasses was added to the basal ration of oat flour forming 10 per cent of the solid portion of a milk-fattening ration. He also noted that molasses did not increase the palatability of the ration. Winter (1929) obtained better gains with slightly increased feed consumption using rations containing 10 or less than 10 per cent cane molasses.

On the other hand, Graham (1906) concluded that it is not economical to use molasses in fattening rations. Results of his experiment showed that rates of gain were about equal for the rations with and without molasses. Hartwell and Kirkpatrick (1911) found

[1] Central Experiment Station Contribution No. 1939. Research Project No. 865 of the Department of Animal Husbandry.

that the addition of sugar to the fattening ration did not result in increased rates of gain or palatability.

To determine whether cane molasses and refined sugar can be profitably used in replacing the greater portion of ground corn in rations for fattening poultry, this study was conducted from September to October, 1956.

MATERIALS AND METHODS

Seventy-five (75) birds were used in 2 one-month trials. Culled one-and-one-half year-old New Hampshire hens were used for trial I, and two-and-one-half month-old cockerels were used for trial II. Three lots of 10 hens each were used for trial I. The same number of lots but with 15 cockerels each were made for trial II. The birds in lot I (control) were fed with a College fattening ration composed of three-fourths corn meal and one-fourth rearing mash; those in lot II, the same fattening ration with 20 parts cane molasses replacing an equal amount of ground corn; and those in lot III, the same ration with 20 parts refined sugar replacing an equal amount of ground corn (table 1).

Before the experiment was started, the birds were leg-banded, individually weighed, and then finally assigned to each lot by blocking them according to their initial weights, degree of fatness, body conformation, and age. The birds were kept in cages for a period of four weeks.

The ingredients of the rations, all parts by weight, are given in table 1.

TABLE 1.—*Composition of the rations fed to the three lots*

INGREDIENT	LOTS		
	I	II	III
Ground corn	75	55	55
Cane molasses	—	20	—
Refined sugar	—	—	20
Rice bran	10	10	10
Rearing mash			
Ground corn	6	6	6
Copra meal	5	5	5
Soybean oil meal	1.9	1.9	1.9
Fish meal	1.9	1.9	1.9
Salt	0.1	0.1	0.1
Aurofac	0.1	0.1	0.1
Total	100.0	100.0	100.0
Crude protein content, %	11.6	11.3	11.0

The ration was fed to the birds as dry mash. Fresh drinking water was made accessible to the birds at all times.

The individual initial and weekly weights of the birds, the amount and cost of feed consumed, mortality, and degree of pigmentation were recorded.

RESULTS AND DISCUSSION

Trial I

Weight of birds. The average initial weights of the birds in the three lots were the same (table 2). Lot 1 (control) birds were consistently heavier than those in lots II and III. At the end of the fourth-week period, the total final weight of the birds in lot I was 22.7 kilograms; lot II, 21.1 kilograms; and lot III, 20.7 kilograms. The differences between the lots were 1.6 and 0.4 kilogram, respectively. The highest total gain in weight was obtained in the control-fed birds, followed by the molasses-fed birds (lot II) and the least was in lot III, refined sugar-fed birds (table 2).

TABLE 2.—*Feed consumption and returns above feed cost for trial I*

ITEM	LOTS		
	I	II	III
Initial total weight of birds, kgms.	17.6	17.6	17.6
Final total weight of birds, kgms.	22.7	21.1	20.7
Total gain in weight, kgms.	5.1	3.5	3.1
Total amount of feed consumed, kgms.	32.6	31.1	34.2
Total cost of feed consumed, pesos [a]	4.56	4.04	6.50
Average consumption of each bird a day, kgm.	0.109	0.104	0.114
Actual returns above feed cost, pesos	5.64	2.96	–0.30

[a] Cost of a kilogram of feed: lot I, ₱0.14; lot II, ₱0.13; and lot III, ₱0.19.
[b] Price of a kilogram of table fowl: ₱2.00 each.

Feed consumption and actual returns above feed cost. During the one-month period in trial I, lot I birds consumed 32.6 kilograms of feed; lot II, 31.1 kilograms; and lot III, 34.2 kilograms. These figures seem to indicate that refined sugar increased the palatability of the ration but effected a very small increase in body weight.

The total cost of feed consumed by the birds in lot I was ₱4.56; lot II, ₱4.04, and lot III, ₱6.50. The higher cost of feed in lot III may be attributed to the slightly heavier feed consumed by the birds, and to the higher cost of a kilogram of refined sugar.[2]

[2] Cost of a kilogram of refined sugar, ₱0.39.

The returns from sales of hens in lot I were slightly higher than those of lots II and III (table 2). Considering the actual return above feed cost, the birds in lot I gained more, compared to the birds given the cane-molasses feed. The refined sugar-fed birds gave a negative result of ₱0.30 (table 2). The loss was attributed to the higher consumption of feed by the birds in lot III with a small total gain in weight, and to the high cost of a kilogram of refined sugar. Based on the average feed consumption of each bird a day, feed conversion efficiency, total gain in weight, and actual returns above feed cost, cane molasses and not refined sugar may profitably replace the greater portion of ground corn in rations for fattening poultry when there is scarcity of corn.

Trial II

Weight of birds. The birds in the three lots had the same average initial weight of 14.5 kilograms The young birds were expected to gain more weight; but at the close of the study, the total final weights of the birds were still very small (table 3). The total gain in weight of the birds in lot I was 4.9 kilograms; lot II, 4.0 kilograms; and lot III., 4.5 kilograms. The least gain in weight of the birds in lot II (molasses-fed lot) may have been due to the small amount of feed consumed by the birds.

Feed consumption and actual returns above feed cost. At the close of the study, lot I birds consumed the most amount of feed, 4.16 kilograms; this was followed by lot III, and the least amount was in lot II.

The least cost of feed consumed was in lot II, ₱3.85, followed by lot I, ₱5.82. In spite of the smaller amount of feed consumed by the birds in lot III compared to lot I, the total cost of feed in the former lot was the highest due to the high cost of a kilogram of refined sugar.

The returns from the sales of cockerels among the three lots did not differ markedly (table 3). However, based on actual returns above feed cost, lot II birds gave the highest, ₱4.15, followed by lot I, ₱3.98, and lot III, the least, ₱2.82.

The feed conversion efficiency slightly differed among the three lots. The cost of feed required to produce a kilogram gain was ₱1.19 in lot I; ₱0.96 in lot II, and ₱1.37 in lot III.

Degree of pigmentation. During the study, the skin, shank, beak, eyering, earlobe, and vent of the birds were observed closely. In both

TABLE 3.—*Feed consumption and returns above feed cost for trial II*

ITEM	LOTS		
	I	II	III
Initial total weight of birds, kgms.	14.5	14.5	14.5
Final total weight of birds, kgms.	19.4	18.5	19.0
Total gain in weight, kgms.	4.9	4.0	4.5
Total amount of feed consumed, kgms.	41.6	29.6	32.5
Total cost of feed consumed, pesos [a]	5.82	3.85	6.18
Average consumption of each bird a day, kgm.	0.092	0.066	0.072
Actual returns above feed cost, pesos	3.98	4.15	2.82

[a] Cost of a kilogram of feed: lot I, P0.14; lot II, P0.13; and lot III, P0.19.
[b] Price of a kilogram of table fowl: P2.00 each.

trials the more deeply pigmented birds were in lot I. This may be attributed to the greater amount of yellow corn present in the ration, since carotene and xanthophyll which are responsible for pigmentation are present in yellow corn. The rest of the birds from all the lots were medium- and light-pigmented.

SUMMARY AND CONCLUSION

Trial I

At the close of the study, the total final weight of lot I was 22.7 kilograms; lot II, 21.1 kilograms; and lot III, 20.7 kilograms.

The total gain in weight of lots I, II, and III, were 5.1, 3.5, and 3.1 kilograms, respectively.

The approximate amounts of feed needed to produce a kilogram gain in weight was 6.39 kilograms in lot I, 8.88 kilograms in lot II, and 11.03 kilograms in lot III.

Based on the actual returns above feed cost, refined sugar is not profitable replacement for ground corn in rations for fattening old hens.

Trial II

At the close of the four-week study, the total final weights of the birds in lot I was 19.4 kilograms; those of lot II, 18.5 kilograms; and those in lot III, 19.0 kilograms.

The total gain in weight of the birds in lot I was 4.9; lot II, 4.0; and lot III, 4.5 kilograms, respectively.

The approximate amount of feed required to produce a kilogram gain in lot I was 8.48 kilograms; lot II, 7.40 kilograms; and lot III, 2.82 kilograms.

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* * *

To know just what has to be done, then to do it, comprises the whole philosophy of practical life.

—*Sir William Osler*

* * *

A scientific hypothesis must live dangerously or die of inanition. Science thrives on daring generalizations. There is nothing particularly scientific about excessive caution. Cautious explorers do not cross the Atlantic of truth.

—*Lancelot Hogben*

PRICES OF COPRA IN THE UNITED STATES[1]

BASILIO N. DE LOS REYES

WITH FIVE TEXT FIGURES

Several factors were found to be associated with the annual price of copra. Of these factors, the general price level influenced the annual price of copra most. A simple correlation analysis showed that the general price level accounted for about 87 per cent of the total variation in the annual price of copra in the United States from 1921 to 1940. With a 10 per cent increase in the price level, the price of copra increased about 29 per cent or almost 3 times as much as the price level. Other factors are the supply of inedible tallow and copra. During the postwar period, none of these factors significantly influenced the annual price of copra, probably due to unstable conditions brought about by the war.

Long-time trends in copra prices in the United States have not been stable. From 1921 to 1940, the purchasing power of copra in terms of all commodities (Wholesale Price Index) in the United States declined at the rate of 2 per cent each year. The average yearly decrease from 1947-53 was 6 per cent or 3 times the decrease before the war.

The seasonal patterns for copra prices have differed somewhat for the two periods studied, 1921-40 and 1947-53. On the average, prices of copra in the United States for the 1921-40 and 1947-53 periods were highest in March. In 1921-40, prices were lowest in August while in 1947-53, prices were lowest in July and August.

Comparing the two prewar decades, prices of copra did not exhibit the same pattern. During the 1921-30 period seasonal peaks in copra prices were in December and February and the seasonal low in July. During the 1931-40, the seasonal high was in March and the seasonal low in August.

The principal and traditional market for Philippine copra is the United States where it competes with domestic oilseeds as a source of oil for the manufacture of soap, margarine, shortening, and various industrial products. As long as the economic ties between the United States and the Philippines exist, any change in the oilseeds industry of the former will affect the local copra industry.

This study was conducted to determine the price movements and factors associated with prices of copra in the United States.

[1] Miscellaneous Contribution No. 33.

FACTORS ASSOCIATED WITH THE ANNUAL PRICE OF COPRA

A simple correlation study of factors associated with the annual price of copra was made to determine which factors were more closely associated with copra prices in the periods 1921-40 and 1947-53. Results of this study are presented in table 1. The percentage of variation represents the proportion of the change in the annual price of copra associated with the variation in the factor. The percentage change is the proportion in which prices of copra change with a 10 per cent increase from the average for the factor.

TABLE 1.—*Gross relationship of various factors to the annual price of copra in the United States, 1921-40 and 1947-53*

FACTOR	PER CENT OF VARIATION	PERCENTAGE CHANGE
1921-40		
Price level	87	29
Total value of copra products [a]	99	12
Prices of related products		
Inedible tallow	81	12
Oil-bearing crops	52	11
Supply		
Copra	29	–8
Inedible tallow	64	–19
1947-53		
Price level	[b]	–3
Total value of copra products	95	9
Prices of related products		
Inedible tallow	30	2
Oil-bearing crops	26	6
Supply		
Copra	5 [c]	6
Inedible tallow	13 [c]	–6

[a] 1933—40 only.
[b] Less than 1 per cent.
[c] Not significant.

Price level. The prices of copra from 1921-40 were closely associated with changes in the price level. The price level accounted for 87 per cent of the total variation in copra prices. During the same period, prices of copra responded sharply to a change in the price level. When the price level rose 10 per cent above average, the price of copra rose 29 per cent, almost 3 times as much as the increase in the price level.

The relation between price level and copra prices during the postwar period was not significant.

Total value of copra products. The combined value of copra products, coconut oil and meal, is closely related to the price of copra. The correlation was almost perfect from 1933 to 1940. From 1947 to 1953 about 95 per cent of the total variation in copra prices was associated with changes in the combined value of copra products.

Prices of related products. Prices of inedible tallow were more closely related to the price of copra than the prices of oil-bearing crops. From 1921 to 1940, prices of inedible tallow and oil-bearing crops were associated with 81 per cent and 52 per cent of the total variation in copra prices, respectively. From 1947 to 1953, prices of inedible tallow and oil-bearing crops were associated with 30 per cent and 26 per cent of the total variation in copra prices, respectively.

Supply. The supply of inedible tallow was more closely related to the price of copra than the supply of copra itself. The supply of inedible tallow accounted for 64 per cent of the total variation in copra prices during the prewar period and 13 per cent during the postwar period. The supply of copra for the prewar and postwar periods accounted for 29 per cent and 5 per cent of the total variation in copra prices, respectively. The relationships between the supply of either product and prices of copra during the postwar period were not significant.

During the prewar period, prices of copra responded more readily to changes in supply of inedible tallow than to changes in the supply of copra. A 10 per cent increase in the supply of inedible tallow for 1921-40 was accompanied by a 19 per cent decrease in copra price. A 10 per cent increase in the supply of copra during the same period was accompanied by an 8 per cent decrease in copra prices.

LONG-TIME TRENDS

The first consideration in showing long-time trends in prices of copra was the calculation of the purchasing power or deflated price in terms of all commodities (Wholesale Price Index) in the United States. A straight line was mathematically fitted to the data by the method of least squares.

The next step was to relate the purchasing power of copra to other oilseeds and to trends in some non-price factors. This involved the calculation of 5-year moving averages from 1921 to 1940, and 3-year moving averages from 1947 to 1953.

Purchasing power of copra in terms of all commodities. The purchasing power of copra in terms of all commodities in the United States declined during the two periods studied, 1921-40 and 1947-53 (fig. 1). The trend line indicates that the index of purchasing power declined from a ratio of 171 (index of copra prices 71 per cent higher than prices of all commodities) at the beginning of the period in 1921 to a ratio of 73 (index of copra prices 73 per cent as high as prices of all commodities) at the close of the period in 1940.

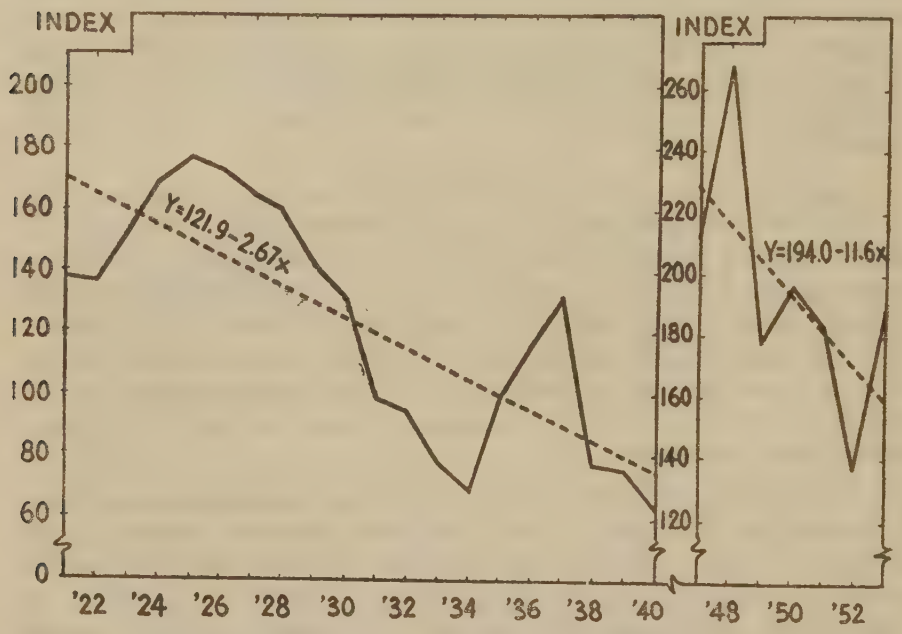

Fig. 1.—Purchasing power of copra in terms of U.S. Wholesale Price Index, 1921-40 and 1947-53 (1935-39 = 100)

The average yearly decrease was about 2 per cent. Much of the decline occurred from 1926 to 1934. During the second half of the 1930's, there was little net change in purchasing power.

The purchasing power of copra was at a very high level after World War II. However, the decline in prices was so rapid that by the end of 1953, it was almost at the same level as during the middle 1920's. Purchasing power declined from an index of 229 in 1947 to 159 at the end of the period in 1953. This represents an average yearly decrease of 6 per cent, about three times as fast as before the war.

Increases in the supply of copra in the U.S. seem to have depressed the purchasing power of copra except during the postwar period when both purchasing power and supply moved together (fig. 2).

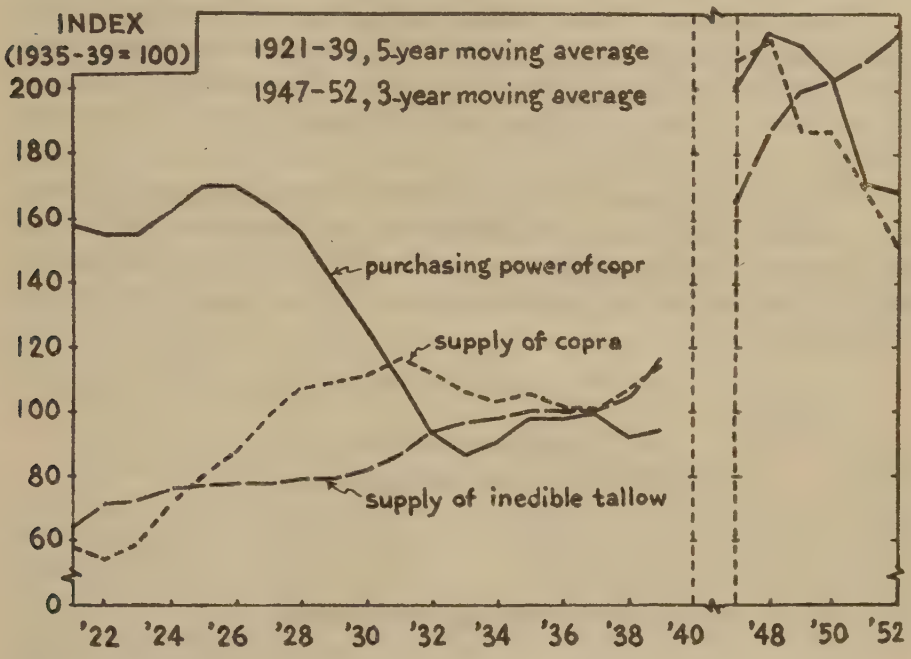

Fig. 2.—Relation of purchasing power of copra to supply of copra and inedible tallow

The high level of purchasing power during the 1920's can be attributed to the low supply of copra. Likewise, the relatively low level of purchasing power during the late 1930's is largely explained by the increase in the supply of copra.

Another factor that may have reduced the purchasing power of copra during the late 1930's was the decreased demand for coconut oil in the production of margarine. Certain states enacted laws during the early and middle 1930's taxing margarine containing nondomestic fats and oils more heavily than other margarine. Under the Internal Revenue Act of 1934 a tax of 3 cents a pound was imposed on the first processing of coconut oil produced in the Philippines or on copra produced in the Philippines.

Figure 2 shows the relation of trends in supply of inedible tallow to purchasing power of copra. It seems that the supply of in-

edible tallow caused more of the long-time changes in prices of copra than the supply of copra during the postwar period. Purchasing power has generally moved in the opposite direction of the supply of inedible tallow.

Copra prices in relation to oil-bearing crops. A composite index of prices received by farmers in the United States for some oil-bearing crops has been calculated since 1910. The composite index includes prices of flax seed, peanuts, cottonseed, and since 1925, soybeans.

The trend in the purchasing power of oil-bearing crops has been more stable than the purchasing power of copra (fig. 3). Both prices were at the same level from 1935 to 1939 but during the 1920's and the postwar period copra prices were higher than prices of oil-bearing crops.

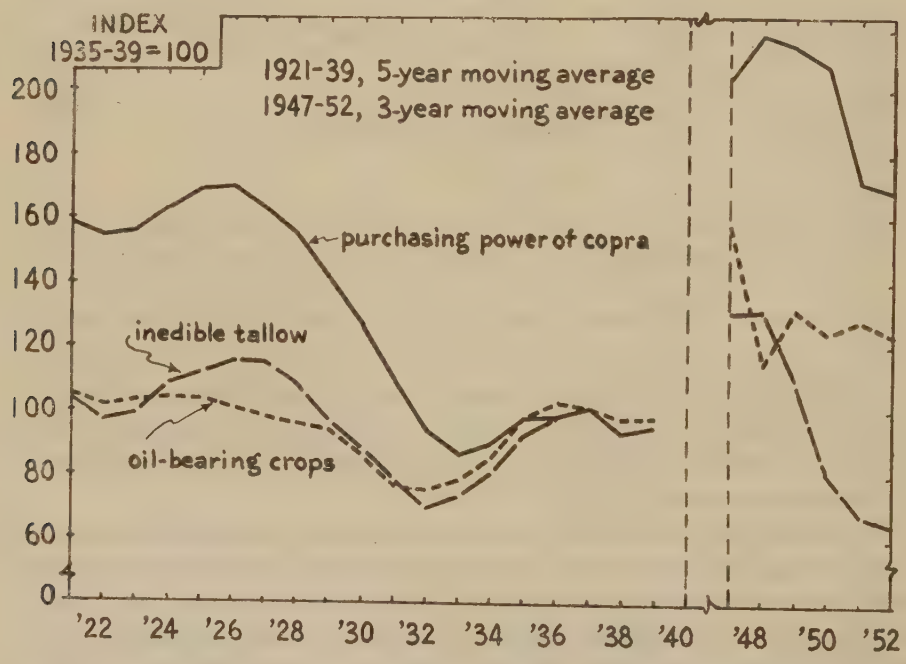

Fig. 3.—Relation of purchasing power of copra to oil-bearing crops and inedible tallow

As stated before, the low purchasing power of copra was due to the decreased demand for coconut oil in favor of domestic fats and oils for the manufacture of margarine. This condition has raised

the level of prices for other oils causing the increase in prices of oil-bearing crops. Another factor that may have caused the increase in prices of oil-bearing crops was the smaller crops from 1934 to 1937 caused by a reported general drought during the period.

Copra prices in relation to inedible tallow. From 1921 to 1926, the purchasing power of copra was much higher than the purchasing power of inedible tallow (fig. 3). Since then, prices of copra declined in relation to inedible tallow reaching its lowest point in 1933. During the same period, the supply of copra increased relatively more than the supply of inedible tallow. The supply of inedible tallow tended to remain more or less stable.

The early postwar period finds the purchasing power of copra much higher than the purchasing power of inedible tallow. However, with the tremendous increase in the supply of inedible tallow, prices declined at a more rapid pace than prices of copra.

SEASONAL VARIATION

The calculation of the indexes of seasonal variation involved the calculation of simple monthly average prices from 1921 to 1930, 1931 to 1940 and from 1947 to 1953. These monthly average prices were adjusted for trends. Indexes of seasonal variation from 1921 to 1940 were the simple average of indexes from 1921 to 1930 and from 1931 to 1940.

Normal seasonal variation. On the average, the prices of copra in the United States from 1921 to 1940 were highest during the month of March (fig. 4). During that month, prices were normally about 6 per cent higher than the years' average. After March, the price steadily declined for 5 months reaching its lowest level in August. The prevailing price in August was about 6 per cent below the years' average. After August, copra prices again improved.

The average seasonal movements in copra prices during the postwar period have differed somewhat from the seasonal movements before the war (fig. 4). Prices for both periods were highest in March but from 1947-53, prices of copra reached its seasonal low in July, one month earlier than before the war. Prices during the postwar period remained low until August. Prices of copra fluctuated from 12 per cent above average in March to 12 per cent below average in July and August. For both periods, prices moved up-

wards starting in September but there was a temporary halt in the upward movement in November and December during the postwar period.

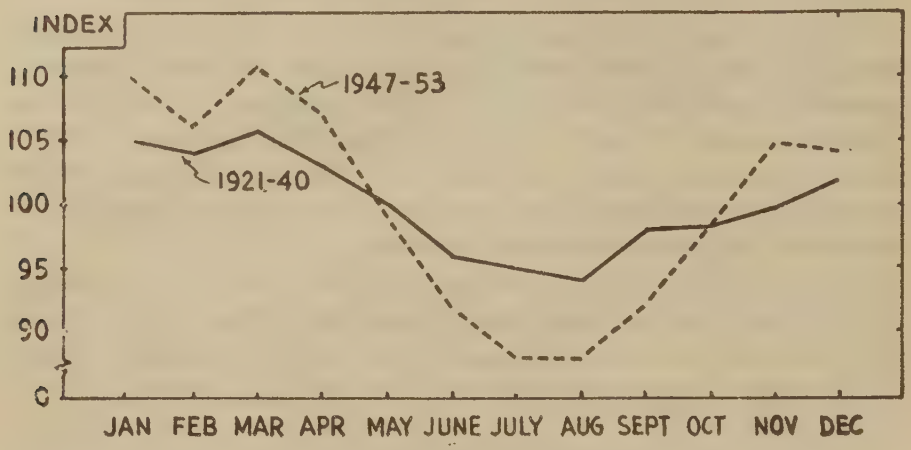

Fig. 4.—Seasonal variation in copra prices, U.S., 1921-40 and 1947-53

Changes in seasonal variation. The pattern of seasonal prices of copra has changed somewhat from the 1920's to the 1930's. The high and low seasonal points in prices came one month later in 1931-40 than in 1921-30 (fig. 5). In the latter period the high points came in December and February and the low point in July. During

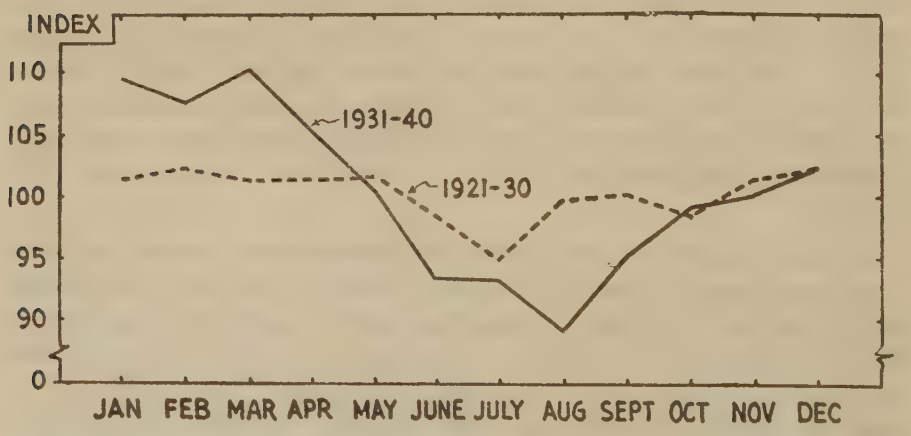

Fig. 5.—Comparison of the seasonal variation in price of copra, U.S., 1921-30 and 1931-40

the period 1931 to 1940, the seasonal high came in March and the seasonal low in August.

Another change in seasonal variation was the amount of variation. The seasonal peaks in copra prices from 1921-30 were about 4 per cent higher than the years' average and the seasonal low was about 6 per cent below average. During the 1931-40 period, the seasonal peak was 10 per cent higher than the years' average and the seasonal low was 12 per cent below the average. In 1947-53 the seasonal variation was from 12 per cent above average to 12 per cent below average. As time passes, the seasonal variation in prices increases.

* * *

Science is the topography of ignorance.

—*Oliver Wendell Holmes*

* * *

"Ours is an eminently agricultural country. It is our duty to pay attention to our agriculture. We should foster to the fullest extent our agricultural development and the agricultural pursuits of our people. The growth of this country must start from the grass roots."

"In agriculture, it is our plan to provide under direct government auspices certain public service projects, such as irrigation and electrification, in order to expand agricultural production: to increase the supply and use of fertilizer, modern agricultural implements and high-yielding varieties, in order to augment the yield of land under cultivation. . . ."

—*Ramon Magsaysay*

THE SUGARS OF LANZONES (LANSIUM DOMESTICUM CORREA)

Sugars are among the chemical constituents of the pulp of lanzones (*Lansium domesticum* Correa) which contribute to its eating quality. To gather information on sugar content in the hope of establishing a criterion on fruit quality, several lanzones trees grown in the orchard of the Department of Agronomy were analyzed for their sugars quantitatively and qualitatively by paper chromatography.

Total, reducing and non-reducing sugars of the pulp of fruits from different trees are presented in table 1.

TABLE 1.—*The sugars of lanzones grown in the orchard of the Department of Agronomy*

TREE NO.	PER CENT Total sugars		PER CENT Reducing sugars		PER CENT Non-reducing sugars	
	A [a]	B [b]	A	B	A	B
Preliminary determinations						
I	9.44	48.74	9.10	46.95	0.32	1.67
II	10.45	52.29	10.10	50.88	0.27	1.34
III	10.16	63.16	9.70	60.34	0.41	2.54
288	11.60	62.91	10.90	59.11	0.69	3.75
410	9.22	60.79	8.94	58.97	0.21	1.37
228	7.44	55.22	7.02	52.07	0.41	3.02
396	4.95	26.24	4.34	23.00	0.58	3.08
22	7.11	37.32	6.46	33.91	0.62	3.25
Mindanao	4.91	20.58	4.05	16.98	0.83	3.48

[a] Based on fresh weight. [b] Based on dry weight.

In all samples there were more reducing sugars than non-reducing sugars. Because of the wide gaps in relative amounts of these sugars, Benedict's solution may be used as a qualitative test for determining the relative sweetness of the fruits.

Glucose, fructose, sucrose and an unidentified oligosaccharide were present in the alcoholic extract of the pulp as revealed by paper chromatographic analysis. Glucose was the predominant sugar.

—APOLINARIO R. CARAÑGAL, JR. and SYLVIA R. ARNALDO

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